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

Module Catalog

M.Sc. Biomass Technology

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

www.tum.de/
www.cs.tum.de/

Module Catalog: General Information and Notes to the Reader

What is the module catalog?
One of the central components of the Bologna Process consists in the modularization of university curricula, that is, the transition of universities away from earlier seminar/lecture systems to a modular system in which thematically-related courses are bundled together into blocks, or modules.
This module catalog contains descriptions of all modules offered in the course of study.
Serving the goal of transparency in higher education, it provides students, potential students and other internal and external parties with information on the content of individual modules, the goals of academic qualification targeted in each module, as well as their qualitative and quantitative requirements.

Notes to the reader:

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

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

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

Index of module handbook descriptions (SPO tree)

Alphabetical index can be found on page 192

Electives Category 1 | Wahlmodule Kategorie 1

Module Description

CS0295: Principles of Life Cycle Assessment | Principles of Life Cycle Assessment

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
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 principle topics in Life Cycle Analysis and systems thinking and life cycle assessment. Learning aids: pocket calculator.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
none

Content:
The module contains units covering the following topics:
• Principles of life cycle thinking
• LCA following the ISO 14040/14044 and ILCD standards
• Selected Life Cycle Impact Assessment Methods such as for
- Climate Change
- Land use and land use change
- Water use
- Resource use
• Attributional and consequential assessments
• Principles of Multi Criteria Decision Analysis (MCDA)
• Presentation and visualization of results
• Handling of data uncertainty

• Current trends and developments
• Software systems and data bases for material flow analysis and life cycle assessment
• Case study

Intended Learning Outcomes:
The students get an introduction into the principle concepts and tools of life cycle assessment to assess products, services and processes regarding their environmental impacts. Thus, they are able to gain a principle understanding of their underlying material and energy flows and how they impact the environment. With these competencies the 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 exercises to introduce the content, to repeat and deepen the understanding as well as practice based on a simple case study.
Teaching / learning methods:
- Media-assisted presentations
- Group work / individual case study
- Computer lab exercises using LCA software systems and Life Cycle Inventory data bases.

Media:
Digital projector, board, flipchart, online contents, case study, 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:
Röder, Hubert; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Principles of Life Cycle Assessment (Lecture) (Vorlesung, 2 SWS)
Röder H [L], Füchsl S, Röder H

Principles of Life Cycle Assessment (Exercise) (Übung, 2 SWS)
Röder H [L], Füchsl S, Röder H
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:
Rühmann, Broder; Dr. rer. nat.

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

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

Module Description

CS0136: Energetic Use of Biomass and Residuals | Energetic Use of Biomass and Residuals [EBR]

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
Assessment consists of a written examination (60 minutes) based on the various potential uses of biomass for energy and a presentation on a concept students have developed individually regarding the use of biomass. The written part constitutes 50% of the grade and the presentation as well with 50%.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Technical Thermodynamics, Energy Process Engineering

Content:
Lectures are dedicated to potential technology for using biomass and residuals as a source of energy. In particular, heat generation, energy conversion, power-heat coupling and the process for generating gaseous and fluid sources of energy are discussed. In addition, the generation of biogas (fermentation process) is discussed in detail. However, as there is another lecture dedicated to this topic, this section will be restricted to the technical basics. Practical exercises focus on conception and planningof plants. As part of a seminar, participants should develop voluntary examples and assess these using an economic efficiency calculation. For the tutorial, students work individually in the group on a concept for biomass use. This concept is analyzed in regard to technical and economic feasibility with the result being presented and assessed in a presentation.

Intended Learning Outcomes:
After completion of the module, students are able to evaluate the various systems for use of biomass. They have got a broad overview of options. In addition, they are able to develop a relevant concept, argue in favour of it, and evaluate the economic profit.

Teaching and Learning Methods:
Lecture (talk by teaching staff) with media, tutorial on calculation of examples, presentation of a voluntary concept regarding biomass or residual use.

Media:
Presentation, script, examples, excursion

Reading List:
Script/
Kaltschmitt, M.; Hartmann, H.; Hofbauer, H.: Energie aus Biomasse, 2. Auflage, Springer, ISBN 978-3-540-85094-6, 2009
Karl, J.: Dezentrale Energiesysteme, Oldenbourg, ISBN 3-486-27505-4, 2004/

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

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

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

Module Description

CS0254: Introduction to Economics of Renewable Resources | Introduction to Economics of Renewable Resources [IntroEconRES]

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
The examination is a written exam (120 minutes). The students demonstrate that, within a limited time and without tools, the economic relationships involved in the use of renewable raw materials have been understood and can be analyzed and further developed in connection with individual company activities. The exam also examines the extent to which the students can characterize the various markets for renewable raw materials and show possible solutions for material and energetic use.

The lecture and exercise "Economics of Renewable Resources" accounts for 65% and the lecture "Markets for Renewable Resources" for 35% of the overall grade.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
None

Content:
The lecture is divided into 3 parts. Although these are independent of each other in terms of content, they address different facets of the economy of renewable resources.

1. Lecture Economics of Renewable Resources
Introduction to the basics of economics using selected conversion paths based on renewable raw materials, from location decisions to procurement and logistics, production, inter-company connections to external reporting.

2. Lecture Markets of Renewable Resources

Presentation of different markets for renewable raw materials. These are divided into material use (bio-lubricants, materials, base chemicals and fine chemicals) and energetic use (heat, electricity and mobility).

3. Exercise Economics of Renewable Resources
The content of the lecture is to analyze and critically evaluate the economics of renewable resources using case studies, so that the participants can independently develop the content further based on the content of the lecture.

Intended Learning Outcomes:
After completion of the module, the students can apply the economic principles of using renewable raw materials in a differentiated manner and analyze and evaluate the economics using case studies from individual companies. Furthermore, they are able to critically assess the business and market relationships in the utilization of renewable raw materials and to include current developments. In addition, the students can assess and compare the different forms of marketing and market sizes of renewable raw materials.

Teaching and Learning Methods:
Lecture; discussions; case studies
With the help of the lectures and exercises, all sub-areas of the module are presented. With the help of this method, the extensive volume of material can be communicated in the best way. In the discussions, the students learn to integrate different perspectives and to correctly classify and critically assess the module content.

Media:
Presentations, script, case studies

Reading List:
Wacker, H., Blank, J. E.: Ressourcenökonomie, Bd. 2 Einführung in die Theorie erschöpfbarer natürlicher Ressourcen, München, Oldenbourg Verlag, 1999.;
KALTSCHMITT, M. und H. HARTMANN (Hrsg.): Energie aus Biomasse. Grundlagen, Techniken und Verfahren. Springer Berlin, 2009;
Vahs, D., Schäfer-Kunz, J.: Einführung in die Betriebswirtschaftslehre. Schäffer-Poeschel Verlag Stuttgart. 2012

Responsible for Module:
Röder, Hubert; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Overview Markets of Renewable Resources (Lecture) (Vorlesung, 1,5 SWS)
Decker T

Management of Renewable Resources (Exercise) (Übung, 1 SWS)
Röder H

Management of Renewable Resources (Lecture) (Vorlesung, 1,5 SWS)
Röder H [L], Pokholkova M, Röder H
For further information in this module, please click campus.tum.de or here.

Module Description

CS0014BOK: BOKU: Post-harvest Technology | BOKU: Post-harvest Technology

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 75	**Self-study Hours:** 45	**Contact Hours:** 30

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

Description of Examination Method:
Written
The mark results from the evaluation of the written exam. The mark of the lecture will be derived from the reached percentage of the points as followed. 90 – 100 % = 1 78 – 89 % = 2 66 – 77 % = 3 55 – 65 % = 4 0 – 54 % = 5 (failed) Duration of the written examination = 60min. For the written exam you can bring calculator, ruler, german/englisch dictionary and the formulary supplied on the bokulearn plattform.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

Content:
Importance of post-harvest technology for the food chain
Biological and physical principles of post harvest technology
Selected post harvest technologies in agriculture:
Treatment of seed (drying, cleaning, sieving,?)
Alternative methods of seed treatments (warm-humid, microwave, high frequency energy)
Drying technology (principles and application; Ddying of agricultural products)
Crop conservation with silage making (principles and processes)
Storage of crops (potato, fruit, vegetable,?); Principles and applications
Special post-harvest technologies in horticulture and viticulture

Intended Learning Outcomes:
Understanding of biological and physical properties of harvested crops and their comprehension

Qualification for systematic analyses of post harvest technology

Qualification for planning of post harvest technology

Evaluation of post-harvest technologies on engineering fundamentals as well as ecological and economic aspects

Teaching and Learning Methods:
interactive lecture

Media:
Lecture, simulation software, presentations

Reading List:
PDF-files of the content are accessible via BOKU learn after login
Additional information will be made available via BOKU learn.
Recommended books will be discussed in the lecture

Responsible for Module:
Viktoria Motsch viktoria.motsch@boku.ac.at Andreas Gronauer Andreas.gronauer@boku.ac.at

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

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

Module Description

CS0015BOK: BOKU: Gender, Food Systems and Natural Resources | BOKU: Gender, Food Systems and Natural Resources

Version of module description: Gültig ab winterterm 2022/23

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:
50% written annotated bibliography (individual grade) 50% presentation/podcast (graded as group work) Both components must be passed in order to pass the course. Students are expected to attend every session. For successful completion of the course attendance of at least 80% of lectures is required.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Interest in the topics relating to this course. Students from a diversity of disciplines and backgrounds are invited to join.

Content:
This course critically assesses how the use, management and knowledge of land, water and the wider ecology is gendered. While women's importance as users, guardians and managers of natural resources and their roles in enabling family food and nutrition security are highlighted globally, the rights to land, water and trees, as well as access to other resources, infrastructure and services, are vested in men. In this course we aim to understand these contradictions, and their implications in different farming systems, practices and socio-political contexts. We will investigate the theory, policy and practice of gender in the governance of food systems and natural resources; and analyse the shortcomings of attempts to integrate women into development programmes. This course will further introduce alternative rights-based approaches to food systems and natural resources, such as food sovereignty, food justice and the right to food, from the perspective of social movements and civil society. In order to achieve a more sustainable use of natural resources it is crucial to understand how and by whom they are used, managed and governed and what are the challenges and barriers, but also the opportunities for different actors. In order

to leverage a transformation toward food and nutrition security for all, a societal transformation is urgently required and more attention has to be paid to underlying structural power dynamics and inequalities among the actors involved. We will assess relevant Sustainable Development Goals (e.g., SDG2, SDG5, SDG12) and the role they play in these processes. To enable students to analyse and/or undertake research on people-nature-food linkages, we will explore conceptual frameworks, analytical insights and methodological tools stemming from different approaches to addressing gender. These frameworks will be based on thematic case studies that will provide deeper insights into different geographic, socio-economic and socio-cultural contexts.

Intended Learning Outcomes:
On completion of this course, students will be able to:
1. Understand meanings and interpretations of gender in theory, policy and practice, and how these impact on the development and governance of food systems and natural resources.
2. Assess how structural inequality and different forms of violence undermine diverse rights of people, with a focus on how this relates to the sustainability of natural resources.
3. Explore how social movements and civil society challenge the dominant agri-food system, focusing in particular on the concept and practice of food sovereignty, food justice and the right to food.
4. Critically assess diverse research approaches and methodologies and the positionality of researchers as well as ethical implications of research.
Students will gain key competences in:
- scientific reading and writing, working with academic literature through guided reading, presenting and discussing readings in class, writing an annotated bibliography (as part of the assessment, 50%)
- media-supported presentation skills, producing a podcast
- team work capacity
- facilitation skills, through active participation in different interactive formats (e.g., World Café, Fishbowl discussion) and online facilitation
- discussions and plenary debate
- peer review: receiving and providing guided feedback

Teaching and Learning Methods:
Learning will be facilitated through a variety of methods which may include lectures, seminars, workshops, presentations by guest speakers, group work and online activities. Students are expected to engage in both class and online activities and discussions. This course also requires students to participate in guided reading and self-directed study to support the learning gained from timetabled sessions. Required and optional readings will be uploaded in advance on BOKUlearn. The emphasis is on student participation and fostering dialogue and debate. Students should feel able to explore and develop their understanding of key concepts introduced in the sessions through discussions in a supportive but challenging environment. Each session will consist of lectures, interactive group activities and/or guest speakers. Case studies presented by guest speakers from academia and civil society, based on research, project and advocacy work, will enable students to gain insights into the social, political, economic and cultural conditions of development and practice in various regions of the world. Through in-class discussions and guided

learning activities, such as peer-review, students will receive continuous feedback, giving an early indication of progress towards the intended learning outcomes.

Media:

Reading List:
Doss, C., Meinzen-Dick, R.S. (2020). Land tenure security for women: A conceptual framework. Land Use Policy 99, 105080. Doi:

Portman, A. (2018). Food Sovereignty and Gender Justice. Journal of Agricultural and Environmental Ethics (2018) 31:455–466. https://doi.org/10.1007/s10806-018-9739-2 Titel anhand dieser DOI in Citavi-Projekt übernehmen

Right to Food and Nutrition Watch (2019). Women's Power in Food Struggles, Issue 11, October, Global Network for the Right to Food and Nutrition. Heidelberg/Berlin: Brot für die Welt & FIAN International.

Tsikata, D., Yaro, J.A. (2013). When a good business model is not enough: land transactions and gendered livelihood prospects in rural Ghana. Feminist Economics, http://dx.doi.org/10.1080/13545701.2013.866261 Titel anhand dieser DOI in Citavi-Projekt übernehmen.

Further required and optional readings will be made available on Moodle

Responsible for Module:
Stefanie Lemke Stefanie.lemke@boku.ac.at

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

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

Module Description

CS0016BOK: BOKU: Aspects of Product Quality in Plant Production | BOKU: Aspects of Product Quality in Plant Production

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 4	**Total Hours:** 100	**Self-study Hours:** 55	**Contact Hours:** 45

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

Description of Examination Method:
Written
Student Seminar Presentation + Seminar Paper

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basic knowledge of plant cultivation, plant breeding and chemistry

Content:
General Section:
- Criteria of crop product quality
- Crop composition (proteins, oils, carbohydrates, fibres, vitamins, toxic components etc.)
- Analytical methods for crop quality determination

Section on Breeding for Quality Characters:
- Genetics of quality characters and quality breeding goals
- Wheat and rye (bread making quality)
- Malting barley, durum wheat and other special-use-cereals
- Oilseed rape and sunflower (oil content, fatty acid profile, ANF´s etc.)
- Soybean (protein and oil content, protein quality, trypsin inhibitor content)
- Fibre crops (fibre content and fibre quality)
- Starch- and carbohydrate-crops

Section on Agronomy:
- Environmental implications of crop quality

- Influence of agronomic treatments and cultivation techniques on crop quality

Practical Section:
- Introduction to NIRS (near-infrared reflectance spectroscopy)
- Breadmaking quality (baking tests, mini-extensograms, dough hardness, dough stickiness, ...)
- Rapid screening methods (tests for Kunitz trypsin inhibitor and for linolenic acid)
- Molecular genetic methods of quality analysis (protein- and DNA-markers)

Processing of crops
- Examples from the food/non-food industries (sugar, oil)

Intended Learning Outcomes:
Understanding the complex of product quality of harvest products. Integrating the effects of agronomy, genotype, environment on crop quality and harvest product utilisation. Experiencing important analytical screening methods used for determination of product quality.

Teaching and Learning Methods:
Lecture, student seminars, laboratory exercises, excursions

Media:

Reading List:
Presentation files are available

Responsible for Module:
Heinrich Grausgruber Heinrich.grausgruber@boku.ac.at

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

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

Module Description

CS0017BOK: BOKU: Plant and Environment | BOKU: Plant and Environment

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 45	**Contact Hours:** 30

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

Description of Examination Method:
Written
written exam, 10 questions, mostly one per chapter, the overall grade results from the sum of the marks for individual questions, (max 11). Points/ grades: <5 points: 5, ≥5: 4, ≥6.5: 3, ≥8: 2, ≥9.5: 1

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

Content:
Introduction - stress, temperature - energy balance, light - quality and quantity, water and drought, flooding and oxygen deficiency, salt, heavy metals and phytoremediation, nitrogen and the N cycle, CO2 and the global carbon cycle; herbivores, pathogenes and defence; genetically modified crops; invasive plants, ecosystem services

Intended Learning Outcomes:
Participants have theoretical and practical knowledge about the interactions between plants and their environment, how different environmental factors affect plants, plant adaptations to and also how plants affect their environment. They understand important local and global cycles. The knowledge establishes a basis for working on applied botanical and ecological problems.

Teaching and Learning Methods:

Media:

Reading List:
script and presentations will be made available via moodle
recommended books:
Schulze et al. Plant Ecology, Springer 2005
Larcher: Physiological Plant Ecology, Springer 2002

Responsible for Module:
Peter Hietz peter.hietz@boku.ac.at

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

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

Module Description

CS0013BOK: BOKU: Chemistry and Technology of Sustainable Resources | BOKU: Chemistry and Technology of Sustainable Resources

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 50	**Self-study Hours:** 20	**Contact Hours:** 30

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

Description of Examination Method:
Written and oral
written (4-5 questions, 60% are required to pass), followed by an oral exam (10 - 15 min) Exams in person at Muthgasse 18, DCH, 3rd Floor, SEM 03/03

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basic courses in chemistry

Content:
The lecture will cover selected topics on cellulose, cellulosic materials, starch and lignin. Including: Cellulose structure, dissolution, chromophores, cellulose solvents, fibers Aging and Degradation: Basic reactions of cellulose degradation, corrosion phenomena, mass-deacidification lignin structure, technical lignins and processes to obtain them, lignin analysis

Intended Learning Outcomes:
Deeper insights into lignocelluloses and biorefineries

Teaching and Learning Methods:
interactive lecture

Media:
interactive lecture

online lecture

Reading List:
Ek et al. (Eds). Pulp and Paper Chemistry and Technology Vol. 1-4, De Gryuter Fengel and Wegener "Wood", Klemm et al., Cellulose and cellulose derivatives" H. Sixta, Handbook of Pulp Holik, Handbook of Paper and Board J. Lehmann, Kohlenhydrate

Responsible for Module:
Thomas Rosenau thomas.rosenau@boku.ac.at

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

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

Electives Category 2 | Wahlmodule Kategorie 2

Production and Supply of Biogenic Resources | Produktion und Bereitstellung biogener Rohstoffe

Module Description

CS0300: Agroforestry Systems | Agroforestry Systems

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
Assessment takes a written form (90 minutes). Students show the extent to which they are able to determine practicable and highly economical alley cropping and apply this knowledge to develop solutions to real-life problems. They are also expected to analyze various ecological aspects such as carbon sequestration and erosion protection with the help of introduced examples. Students demonstrate their understanding of the topic when answering questions on crop processing systems.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basics in Silviculture

Content:
Role and distribution of agroforestry systems in Germany and all over the world. Introduction to special agroforestry systems for production of renewable resources and their importance. Establishment and use of agroforestry systems. Ecological impact of agroforestry systems: interactions between trees and agricultural systems, competitive relationships, carbon sequestration, CO2 avoidance, erosion protection, dynamics of soil moisture, biomass production, economic evaluation and funding options, propagation and harvesting of appropriate plants, potential applications of crops (e.g. in firing systems).

Intended Learning Outcomes:
Students are able to discuss the ecological and economic potential of agroforestry systems for production of renewable resources. They can evaluate the performance of agroforestry systems and apply concepts for agroforestry systems of typical areas (selection of appropriate wood plants and use systems, localisation of forest belts for optimal performance in the ecosystem). Students can evaluate agroforestry systems and crop use from a basic economical perspective (efficiency analysis, risks, marketing and strategies for their use).

Teaching and Learning Methods:
Lectures introduce basic knowledge; tutorials on identification of appropriate trees and bushes. Excursion to agroforestry systems in active and trial operations, demonstrating possible damages and causes.

Media:
Lectures given as presentations, examples, group work, case studies

Reading List:
Anbau und Nutzung von Bäumen auf landwirtschaftlichen Flächen Gebundene Ausgabe – Wiley-VCH Verlag GmbH & Co. KGaA; Auflage: 1. Auflage 2009
Tatjana Reeg, Albrecht Bemmann, Werner Konold, Dieter Murach, Heinrich Spiecker;
Kurzumtriebsplantagen: Holz vom Acker - So geht's Taschenbuch – DLG-Verlag, 2012
Dirk Landgraf, Frank Setzer;
Aktuelle Veröffentlichen in Fachzeitschriften

Responsible for Module:
Höldrich, Alexander; Dr. agr.

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

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

Module Description

CS0018BOK: BOKU: Soil Protection | BOKU: Soil Protection

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 45	**Contact Hours:** 30

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

Description of Examination Method:
Written

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Fundamentals of soil science (at least bachelor level, ideally the level after passing the exam of 911.014 - Soil Science Refresher) Proficient English

Content:
Introduction - Global issues and drivers of soil loss and degradation (theory / lecture) - Major soil threats at global, European and national level (theory / lecture) - Case studies covering different aspects of soil degradation and soil management (blended learning component: homework, peer review workshop).

Intended Learning Outcomes:
Overall aim: Provide an overview on major problems of soil protection and sustainable land use at global, European and national (Austrian) level. Objectives: - make you familiar with the main soil threats at global, european and national level - make you familiar with (sources of) information on the current state of soil - give you an appreciation of instruments of soil protection and their application to specific problems - encourage critical evaluation and challenging of current concepts of soil protection - provide guidance for informed use of soil information and decision making - enable you to develop possible solutions for better protection of soil Expected learning outcomes: - Know and comprehend fundamental soil threats - Recall the main soil threats - Know about major drivers and causes of soil degradation - Put them into context of natural, societal and economic conditions - Rank their relative importance at national, European and global level - Know about the state of soil (degradation) - Recall major pattern of soil degradation at national and European scale

- Know about sources of soil information and their application - Recall important sources of soil information in Austria, Europe and at global level - Make informed use of soil information - Know about instruments / measures of soil protection - Apply your knowledge to a case study

Teaching and Learning Methods:
interactive lecture

Media:

Reading List:

Responsible for Module:
Walter Wenzel walter.wenzel@boku.ac.at

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

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

Module Description

CS0020BOK: BOKU: Agricultural Engineering in Plant Production | BOKU: Agricultural Engineering in Plant Production

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 4	**Total Hours:** 100	**Self-study Hours:** 55	**Contact Hours:** 45

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

Description of Examination Method:
The overall course grade is compiled from evaluations in the following three areas: 1. Evaluation of active participation during course meetings with mandatory attendance (15 points) 2. Evaluation of the final paper (40 points) 3. Evaluation of the final presentation (45 points) Grades The grades for the course will be calculated according to the number of points achieved and based on the following grading scale: 90 – 100 Points = very good (1) 78 – 89 Points = good (2) 66 – 77 Points = satisfactory (3) 55 – 65 Points = adequate (4) 0 – 54 Points = inadequate (5)

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Precense in the first lecture. Mainly students from 455 plant science and other free places for other master students. Others will be given to students by the system: first come first serve.

Content:
The course focuses on special topics in the field of agricultural engineering in plant production. This course builds upon the content of the courses “Fundamentals of Agricultural Engineering“ (931.103), “Agricultural Engineering in Plant Production“ (931.100) as well as „Agricultural Engineering in Plant Production - practical course“ (931.101). Students will delve into various aspects of agricultural engineering by researching and writing literature comparison papers. One focus of the course is to work with scientific literature in English and correctly use English technical terms. The course is designed to be interdisciplinary and covers process engineering (through the detailed examination of process engineering aspects of agricultural engineering), plant production aspects (by conveying the technical requirements based on plant

production conditions), as well as sustainability aspects (by evaluating the environmental effects, future viability). The course's primary aim is not simply to communicate detailed information on agricultural engineering, but rather to contribute to a critical evaluation of processes and innovations in the course's areas of focus, as well as to determine problems and challenges in the selected fields of application.

Intended Learning Outcomes:
Upon positive completion of the course, students will be able to: • Give an overview of special topics in the field of agricultural engineering • Confidently use scientific literature (search, use and correctly cite literature) • Critically evaluate scientific literature • Participate in discussions based on the analysis of scientific literature and determine development potential, risks and open research areas

Teaching and Learning Methods:
The topic of the course paper can be chosen from a pool of topics, however each topic may only be researched once. The topic will be presented and clarified during the last course units. The content of the course paper will be a critical examination of one technology. The final paper should be structured as follows: 1. A short summary of the technology and its current state of development (ca. 500 words) 2. A summary of the technologies/innovations as described in the literature (ca. 1,000 words) 3. A critical evaluation of innovations (benefits, drawbacks, practical applicability), discussion supported by literature data (ca. 1,000 words) 4. A conclusion (max. 100 words) The course paper will be written about the individual technologies in 3-person groups. The course paper should be as short and concisely written as possible (no comprehensive "summary" of the literature); the suggested length of the paper is approximately 5-6 pages (2,600 words not counting the bibliography). The course papers should be based on the content of at least 10 scientific publications written in English. Results of the course paper will be presented visually in the concise format of a poster. Course leaders will make a template for the poster available to all course participants. Upon positive evaluation, posters will be approved for printing.

Media:

Reading List:

Responsible for Module:
Christoph Pfeifer

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

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

Module Description

CS0063BOK: BOKU: Crop Production | BOKU: Crop Production

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 52	**Contact Hours:** 23

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

Description of Examination Method:
Written and oral
There is a written exam shortly after the end of the course. It takes roughly half an hour and consists of about 15 questions in multiple choice mode or requiring very short written answers. Each question allows for an indicated number of points, which are given according to the correctness of the answer. A minimum of 50% of the points are necessary to pass. Marks are given relative to the number of marks exceeding that minimum.
Students who are not able to attend that exam are offered oral exams based on individual appointments. The questions will be selected from the previous written exam and the affiliation of marks is again related to the correctness of answers.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basic knowledge in (plant) biology and physics on Matura level

Content:
Block A: Introduction to agronomy
1. Introduction
- Definition of course contents and objectives
- Arable crops and grassland as elements of agro-ecosystems
2. Historical view
3. Effects of environmental factors on field crops
4. Germination and crop establishment
5. Growth, development and yield formation
6. Crop husbandry
7. Environmental impacts of field crops

8. Systems of crop production - conventional/integrated/ecological agriculture

Block B: Fodder crops and catch/cover crops, grain crops rich in carbohydrates (cereals)
1. Botanical classification
2. Environmental needs
3. Definition, assessment and production of yield and quality
4. Crop husbandry

Block C: Grain crops rich in protein or oil; root and tuber crops; renewable resources
1. Botanical classification
2. Environmental needs
3. Definition, assessment and production of yield and quality
4. Crop husbandry

Intended Learning Outcomes:
Students acquire knowledge about field crop production with emphasis on the underlying physical, chemical and biological processes, also with view to environmental claims

Students can draw conclusions on suitable crop management practices

Students acquire detailed knowledge about environmental needs, yield, product quality and crop husbandry of important arable crop species in temperate climate zones

Teaching and Learning Methods:
Classroom lecture, assisted by moodle

Media:
course material available at BOKUlearn (Moodle)

Reading List:

Responsible for Module:
Hans-Peter Kaul (BOKU)

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

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

Module Description

CS0021BOK: BOKU: Crop Production Systems in Organic Agriculture | BOKU: Crop Production Systems in Organic Agriculture

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 45	**Contact Hours:** 30

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

Description of Examination Method:
written
Calculation of balances: example should calculated on student´s notebook and have to be submitted to BOKUlearn during the examination period

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in organic plant production (crop rotation)

Content:
Investigation and development of cropping systems with balance and planning instruments:

- designing of crop rotation
- fodder and straw balance
- organic manure planing
- nutrient balances (field, farmyard balance)
- humus balance

Intended Learning Outcomes:
Qualification for the system approach of organic farming land use systems:
- understanding of crop rotation interactions with soil, weeds and pests
- understanding connection between crop rotation, plant nutrition, fertilizer distribution, nutrient and humus balances
- understanding of nutrient and carboncycles between field and live stock (fodder budget)

Teaching and Learning Methods:
Lecture with exercises

Media:

Reading List:
Freyer, B. 2003: Fruchtfolgen - konventionell, integriert, biologisch. Verlag Eugen Ulmer, Stuttgart

Responsible for Module:
Gabriele Gollner Gabriele.gollner@boku.ac.at

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

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

Module Description

CS0044BOK: BOKU: Procedures of Plant Production in Organic Agriculture I | BOKU: Procedures of Plant Production in Organic Agriculture I

Version of module description: Gültig ab winterterm 2022/23

Module Level:	Language:	Duration:	Frequency:
Credits:* 1	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

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

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

Module Description

CS0045BOK: BOKU: Global Waste Management I | BOKU: Global Waste Management I

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:**	**Duration:**	**Frequency:**
Credits:* 3	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

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

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

Module Description

CS0046BOK: BOKU: Waste Management Seminar | BOKU: Waste Management Seminar

Version of module description: Gültig ab winterterm 2022/23

Module Level:	Language:	Duration:	Frequency:
Credits:* 4	**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.

Chemical-Material Use | Chemisch-stoffliche Nutzung

Module Description

CS0003: Production of Renewable Fuels | Production of Renewable Fuels

Version of module description: Gültig ab winterterm 2023/24

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

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

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

Repeat Examination:
End of Semester

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

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

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

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

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

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

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

Courses (Type of course, Weekly hours per semester), Instructor:
Production of renewable fuels (Tutorial, Straubing) (Übung, 2 SWS)
Burger J [L], Burger J, Groh D, Rosen N

Production of renewable fuels (Tutorial, Garching) (Übung, 2 SWS)
Burger J [L], Burger J, Groh D, Staudt J

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

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

Module Description

CS0265: Biorefinery | Biorefinery [BioRaff]

Version of module description: Gültig ab winterterm 2023/24

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

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

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

Repeat Examination:
Next semester

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

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

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

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

Media:
PowerPoint presentation, blackboard

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

Responsible for Module:
Schieder, Doris; Dr. rer. nat.

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

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

Module Description

CS0266: Sustainable Chemistry | Sustainable Chemistry

Version of module description: Gültig ab summerterm 2024

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

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

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

Repeat Examination:
Next semester

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

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

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

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

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

Media:
Presentation, script, examples

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

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

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

Module Description

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

Version of module description: Gültig ab summerterm 2024

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

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

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

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

Repeat Examination:
Next semester

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

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

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

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

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

Media:
Presentations, slide notes

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

Responsible for Module:
Fink, Bettina; Dr. rer. nat.

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

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

Module Description

CS0022BOK: BOKU: Processes in Enzyme Technology | BOKU: Processes in Enzyme Technology

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 50	**Self-study Hours:** 20	**Contact Hours:** 30

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

Description of Examination Method:
Oral

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

Content:
The course will provide an overview of the key enzymes currently used in industrial processes. An overview of the technical use of enzymes and the possibilities to change and improve enzyme performance for adaptation to technical applications including enzyme optimization through enzyme discovery and engineering will be presented. A number of case studies highlighting the use of enzymes in industries e.g., starch conversion, food production, textile, wood fiber processing, biofuel production etc. will be explored.

Intended Learning Outcomes:
After passing the course, the students should be able to:
- understand the fundamentals of catalytic principles, enzyme kinetics and reaction mechanisms,
- explain the key structural factors which give rise to increased enzyme stability important for industrial applications,
- describe methods for selection and optimisation of industrial enzymes using genetic and biochemical techniques,
- describe and evaluate methods for enzyme immobilization and for characterization of the properties of immobilized enzymes

- describe a contemporary application of enzyme technology and present in a well-structured oral presentation.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
Thu Ha Nguyen thu-ha.nguyen.ac.at

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

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

Module Description

CS0023BOK: BOKU: Biochemical Technology | BOKU: Biochemical Technology

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 2	**Total Hours:** 50	**Self-study Hours:** 20	**Contact Hours:** 30

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

Description of Examination Method:
Written and oral
oral exam dates can be arranged individually alternative, students can hand in a term paper (approx. length should be 15 pages) on a topic of biochemical technology which must be based on original literature and cover microbiological, biochemical and technological aspects of the production of selected chemicals / industrial products. These topics for the term paper can be selected individually

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
basic knowledge in microbiology and biochemistry (main metabolic pathways in microoragnisms) as wel as in biotechnology (cultivation of microorganisms, fermentation technology)

Content:
1. The lecture on 'biochemical Engineering' will give details about the production processes of some of the most important substrates used for fermentative processes or further transformations, starch, sucrose and plant oils. Alternative production of oil through fermentation by yeasts, fungi and algae.
2. Introduction to enzymes, enzyme catalysis and enzymatic processes; use of enzymes to produce glucose syrup from starch; enzymatic systems involved in the degradation of lignocellulose and conversion of lignocellulosic polysaccharides to fermentable sugars, enzymatic esterification in the production of biodiesel
3. fermentation processes to produce ethanol and other alcohols; lactic acid, succinic acid and other building blocks for the chemical industry; use of metabolic engineering to improve these fermentation processes

4. biocatalysis, definition, challenges and major examples

Intended Learning Outcomes:
after completing the course on 'Biochemical Technology' students will have a profound knowledge of important sources for fermentable sugars, enzymatic conversion of various polysaccharides to fermentable sugars, and the production of major chemical building blocks through fermentation and biocatalysis

Teaching and Learning Methods:
multimedia-supported

Media:
multimedia-supported

Reading List:

Responsible for Module:
Dietmar Haltrich dietmar.haltrich@boku.ac.at

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

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

Module Description

WZ9483BOK: BOKU: Biomimetics - Technical Solutions from Nature | BOKU: Bionik - technische Lösungen aus der Natur

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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:
written

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
No specific previous knowledge expected!
COURSE LANGUAGE IS GERMAN!

Content:
The scientific discipline bionics is concerned with the technical implementation & application of construction, processing & development principles of biological systems. Since the beginning of time, we have been learning from Nature. Today, innovation pressure & the necessity to find sustainable, resource efficient & “mature” solutions for questions & problems of our society have tremendously increased. By thorough understanding biologically optimized systems, we can obtain better solution in a faster way, by making millions of years of evolution & selection part of our research & development work.

The lecture „Bionics – technical solutions from Nature” is devoted to the following contents:
- Systematic introduction to the scientific areas of bionics
- Historical & state of the art examples, to understand the methodical approach of bionics
- Development of a fundamental understanding of the functionality of selected biological systems
- Illustration of technical applications in “bionic” products or processes as well as further possible fields of application

The lecture is held in 2 parts:

Part 1: Introduction and bionics in the animal kingdom (H. Lichtenegger)
1. Introduction: pioneers of bionics & their achievements, bionics as science, bionic approach, difference to “pseudobionics”
2. Principle of a bionic invention, example of the Bionic Car
3. Surfaces: to glide or to stick, this is the question. The tricks of sharks, sand fish and geckos, and their application.
4. High performance materials: as hard as nacre, as tough as spider silk or as shiny as a butterfly? The inner structure is key.
5. Self-assembly: principles in Nature and transfer to artificial systems.
6. Flying through the sky, a human accomplishment: what is it to do with bionics today?

Part 2: Bionics from the world of plants (N. Gierlinger)
1. Bionic “classics” from the world of plants
2. Always clean: super-hydrophobic plant surfaces – from the example to the product
3. Well protected and densely packed: Examples from the world of plants
4. Stable light weight constructions, shape optimization and self-repair: what can we learn from trees, grass, lianas & co?
5. Movement in plants as example for technical applications?

Intended Learning Outcomes:
Students graduating from this course have basic knowledge about principles of bionics. They can cite and explain examples of successful bionic applications and have the basic insight necessary for potential transfer of concepts found in nature to technical problems.

Teaching and Learning Methods:
multimedia-supported

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung (2 ECTS)
Bionik - technische Lösungen aus der Natur (LV-Nr. 892325)
2 SWS
Notburga Gierlinger, Helga Lichtenegger

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

Module Description

WZ9427BOK: BOKU: Chemicals from Biomass | BOKU: Chemikalien aus Biomasse

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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:
oral

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
General and organic chemistry

Content:
Master HTM - Modul Bioraffinerie

The lecture gives a short introduction into the different classes of primary and secondary natural materials.

Based on the corresponding properties of these natural materials substantial applications and utilisations within the framework "Chemicals from Biomass" are elaborated and described.

Intended Learning Outcomes:
Master HTM - Modul Bioraffinerie
Establish understanding of interrelationship of the different classes of primary and secondary natural materials, their properties and resulting possible usage. Deepening knowledge about connectivity of chemical properties and usage as biobased chemicals.

Teaching and Learning Methods:
Class lecture

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung (2 ECTS)
Chemikalien aus Biomasse (LV-Nr. 774326)
2 SWS
Sabine Baumgartner, Stefan Böhmdorfer

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

Energetic Use | Energetische Nutzung

Module Description

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

Version of module description: Gültig ab winterterm 2023/24

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

Responsible for Module:
Kainz, Josef; Prof. Dr.

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

Module Description

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

Energy Processes Engineering

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
Assessment takes the form of a written examination (90 minutes). Students demonstrate their ability to solve basic calculations and apply methods of process technology to different issues. In addition, some questions on energy and process technology plants are to bei answered in a written form.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Technical Thermodynamics

Content:
Within the modul the thermal and chemical components of power plants and process engineering plants such as combustion concepts, fuel treatment, exhaust gas purification, production of fuels from biomass and electricity generation concepts are explained. The basics of the design and calculation of steam generators, reactors and synthesis algae and the treatment of gases from gasification processes and their use e.g. in a fuel cell are explained.

Intended Learning Outcomes:
At the end of the module students can understand complex processes for energy and/or fuel production and are able to detect and explain the required needs (e.g. pressure, temperature) and process technologies.

Teaching and Learning Methods:
The module consists of lectures and tutorials. The contents will bei taught in lectures and presentations.

Media:
Lecture, blackbboard, presentation

Reading List:
Kaltschmitt, M.; Hartmann, H.; Hofbauer, H.: Energie aus Biomasse, 2. Auflage, Springer, ISBN 978-3-540-85094-6, 2009
Spliethoff, H., Power generation from Solid Fuels, Springer, ISBN 978-3-642-02855-7, 2010
Karl, J.: Dezentrale Energiesysteme, Oldenbourg, ISBN 3-486-27505-4, 2004/
Sterner, M.; Stadler, I.: Energiespeicher, Springer Vieweg, ISBN 978-3-642-37379-4, 2014

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

Courses (Type of course, Weekly hours per semester), Instructor:
Energy process engineering (Exercise) (Übung, 3 SWS)
Gaderer M [L], Gaderer M

Energy process engineering (Lecture) (Vorlesung, 2 SWS)
Gaderer M [L], Gaderer M
For further information in this module, please click campus.tum.de or here.

Module Description

CS0260: Energy and Economics | Energy and Economics [EUW]

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
The examination will take the form of a written test (60 minutes). The students prove that they can understand and answer questions and the connections between the energy conversion, the conversion of renewable raw materials, the energy supply in general and the current energy-political and economic situation. Group work can be included and be part of the exam.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Prior participation and passing of the fundamentals of Thermodynamics module is required for participation in the Energy and Economics module.

Content:
The module deals with the basics of energy sources, climate change and the technology of the heat, electricity and fuel market and the use of renewable raw materials, including an introduction to simple technical systems and current topics on the energy industry. It also deals with electricity trading, CO2 trading and the current situation of various energy technologies.
In exercises small examples are calculated to the economy (production costs of heat and power of plants (e.g. combined heat and power plants).

Intended Learning Outcomes:
By participating in the module, students will be able to understand the energy sources and simple principles of energy conversion into heat and electricity. They can perform simple economic assessments of energy systems and understand related market mechanisms of the electricity and heat market.

Teaching and Learning Methods:
The module consists of a lecture with exercises. The contents of the lecture are conveyed in the lecture and through presentations.

Media:
Presentations, exercise

Reading List:
Kaltschmitt, M.; Hartmann, H.; Hofbauer, H.: Energie aus Biomasse, 2. Auflage, Springer, ISBN 978-3-540-85094-6, 2009
Karl, J.: Dezentrale Energiesysteme, Oldenbourg, ISBN 3-486-27505-4, 2004/

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

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

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

Module Description

CS0026BOK: BOKU: Energy Engineering | BOKU: Energy Engineering

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 45	**Contact Hours:** 30

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

Description of Examination Method:
written
Multiple Choice Test: 30 Fragen in 60 minutes, 1-5 answers could be correct

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Physics including thermodynamics (e.g. VO 892.104 + VO 893.103 or VO 892.105 + VO 893.112)

Content:
Steam power plants • Combined heat and power (CHP) production • Waste incineration plants • Gas turbine combined cycle power plants • CO2 capture and storage • Power to Fuel (Gas / Liquid) • Heat grids and district heating systems • Heat pumps and active waste heat recovery • Energy technology in buildings

Intended Learning Outcomes:
The students know the essential parts of the present energy system and the approximate share of the different primary energy sources in Austria. • The students know the basic principles of energy conversion including the conversion of thermal energy to electrical energy. • The students know examples of practical energy conversion units and are able to explain the processes. • The students are able to discuss different energy conversion routes on a comparative basis.

Teaching and Learning Methods:
class lecture

Media:

Reading List:

Responsible for Module:
Tobias Pröll tobias.proell@boku.ac.at

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

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

Module Description

CS0058BOK: BOKU: Renewable Energy Resources | BOKU: Renewable Energy Resources

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 41	**Contact Hours:** 34

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

Description of Examination Method:

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Fundamentals of physics and thermodynmacis

Content:
Energy demand and energy supply for Austria / EU. Overview of the thermodynamic fundamentals of energy conversion and introduction to the energy use (heat, electricity, fuels).
Renewable energy sources: use of solar energy for thermal use and photovoltaics, combustion calculation, thermo-chemical biomass conversion (pyrolysis, gasification, combustion, hydrothermal processes), hydropower (run-of-river, reservoir and storage power plant), geotherma energy, wind energy, biogas (anaerobic fermentation)

In the winter semester, the lecture will be offered live on the dates listed below via Zoom. Details and teaching materials can be found in the relevant BOKUlearn course.

Excursion:
It is not clear if the field trip can be provided in the winter term 2020/21. In case of cancellation a homework will be given (details can be found in the BOKUlearn course). Participation/homework contributes to the assessment of the course to 20% but is not mandatory.

Intended Learning Outcomes:
Understanding of the processes for energy utilization, competence in explaining processes and being able to compare them with one another, knowledge of thermodynamic fundamentals and physical terms

Teaching and Learning Methods:

Media:

Reading List:
Vorlesungsunterlagen werden über BOKUlearn bereitgestellt.

Responsible for Module:
Rafat Al Afif rafat.alafif@boku.ac.at

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

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

Economics | Ökonomie

Module Description

CS0202: Empirical Research Methods | Empirical Research Methods

Version of module description: Gültig ab winterterm 2023/24

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

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

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

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

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Mathematics, Statistics

Content:
This course aims to enable students to understand empirical research. The course explains how research works and how to identify sources that meet a certain level of academic rigor to be

trustworthy. This is important as only trustworthy information should become a source of learning and a foundation of managerial or political decision making.

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

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

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

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

Learning Objectives
At the end of this module, students will be able to demonstrate understanding, critical assessment and application of the following:
• assess (pseudo-)scientific work
• understand and evaluate potential approaches toward answering academic questions

• utilize tools and techniques of empirical research for their own future studies

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

Media:
Powerpoint, Board, Videos, Flipchart, Debates

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

Responsible for Module:
Goerg, Sebastian; Prof. Dr. rer. pol.

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

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

Module Description

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

Version of module description: Gültig ab summerterm 2024

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

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

Description of Examination Method:
Learning outcomes are verified in a written exam (90 minutes). Students show the extent to which they have understood the taught game-theoretical definitions and terminology. 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 and answer comprehension questions concerning the properties and the advantages and disadvantages of the different solution concepts.

Repeat Examination:
End of Semester

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

Content:
Cooperative and non-cooperative games, solution concepts for cooperative games, core, Shapley value, solution concepts for non-cooperative games, pure Nash equilibria, mixed Nash equilibria, dominant strategies, Bayesian games, modeling concrete case studies related to sustainability as cooperative and non-cooperative 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 sustainability-related 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:
Thielen, Clemens; Prof. Dr. rer. nat.

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

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

Module Description

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

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** 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 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. The seminar paper demonstrates the student's ability to summarize the literature, explain research methods, present research findings and discuss them approbriately.

Repeat Examination:
End of 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:
Cartwright, E. (2018). Behavioral economics. Routledge.
Davis, D. D., & Holt, C. A. (2021). Experimental economics. Princeton university press.
Additional current research articles will be provided during the seminar

Responsible for Module:
Goerg, Sebastian; Prof. Dr. rer. pol.

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

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

Module Description

CS0068: Intermediate Microeconomics | Intermediate Microeconomics [Micro II]

Version of module description: Gültig ab winterterm 2023/24

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

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Microeconomics

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

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

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

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

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

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

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

Responsible for Module:
Goerg, Sebastian; Prof. Dr. rer. pol.

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

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

Module Description

CS0027BOK: BOKU: Resource Efficiency and Bioeconomy of Bio-based Materials | BOKU: Resource Efficiency and Bioeconomy of Bio-based Materials

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 45	**Contact Hours:** 30

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

Description of Examination Method:
Ongoing evaluation within the framework of the course (examination immanence)

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
•Environment and society: regional and global developments
•Resource efficiency, material efficiency, sustainability
•Cascading usage concepts with wood and their evaluation
•The cradle-to-cradle principle and product and process innovations derived from it
•Bioraffineriekonzepte
•Material resource efficiency and economic development
•Evaluation of resource and material efficiency
•Improving resource efficiency and innovation strategies
•Resource efficiency in agriculture, forestry, wood industry, industrial biotechnology and its assessment (case studies)
•Definitions of the bioeconomy as well as international strategies and scenarios
•Sustainable bioeconomy, the bioeconomy "at any price", ethical aspects
•Products made from renewable raw materials and residues (building materials, insulation materials, bio-based composites, adhesives, biopolymers, bio-based lightweight materials, special products, etc.)

Intended Learning Outcomes:
•Define "resource efficiency" qualitatively and quantitatively.
•A sound understanding of the term bioeconomy is available, including currently defined strategies for implementation.
•Ability to discuss and evaluate critical and controversial issues in the context of resource efficiency or bioeconomy, including ethical and societal aspects.
•Cradle-to-Cradle is understood as a possible guiding principle of the future.
•Students are familiar with best-practice examples.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
Georg Gübitz Georg.guebitz.boku.ac.at

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

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

Module Description

CS0036BOK: BOKU: Resource and Environmental Economics | BOKU: Resource and Environmental Economics [CS0036BOK]

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
Written

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Introductory economics and concepts of sustainability. Students are provided with refreshment slides/material in BOKUlearn and a short self-assessment quiz.

Content:
1. Principles of welfare economics;

2. Environmental Economics (Concept of Externalities: Environmental Targets and Policy Instruments);

3. International Environmental problems (Economic analysis of Climate Change, Biodiversity)

4. Economics of renewable and non-renewable Resources;

5. Irreversibility, Risk, and Uncertainty

Intended Learning Outcomes:
The Course shoul help

* to develop a strong understanding of the fundamental principles of environmental and resource economics;

* to strengthen the ability to read and synthesize papers in applied economics;

* to foster creative and independent thinking about problems in the area of environmental and resource.

Teaching and Learning Methods:
class lecture

Media:

Reading List:
Recommended Reading
Perman, Roger, Yue Ma, Michael Common, David Maddison and James McGilvray (2011): Natural Resource and Environmental Economics. 4thedition. Pearson Education Limited, Edinburgh Gate. (see library)

Responsible for Module:
BOKU Karner Katrin Institut für Nachhaltige Wirtschaftsentwicklung

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

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

Management | Management

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:
Fröhling, Magnus; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Sustainable Production (Vorlesung) (Vorlesung, 2 SWS)
Fröhling M [L], Heinrich V, Schirmeister J

Sustainable Production (Übung) (Übung, 2 SWS)
Fröhling M [L], Schirmeister J, Heinrich V
For further information in this module, please click campus.tum.de or here.

Module Description

CS0128: Corporate Sustainability Management | Corporate Sustainability Management [CSM]

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
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 strategic and operational sustainability management.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
The Corporate Sustainability Management module includes a detailed discussion of the term sustainability (three-pillar model) and the history of the content. Based on this, the basic premises for sustainable management and sustainable economic activity are derived and discussed in a social, political, environmental, economic and corporate context. The national, European and international strategies for sustainable management are presented (e.g. bioeconomy, circular economy, green economy). Furthermore, established measurement concepts and key performance indicators (KPIs) for sustainability (e.g. resource productivity, life cycle costing) are discussed and applied to exemplary products and value chains within the framework of "Corporate Social Responsibility Reporting".

Intended Learning Outcomes:
After completion of the module, the students are able to understand sustainability concepts and to compare sustainability-oriented corporate profiles as a supplement to value-added corporate development. They can develop and apply concepts for the derivation, evaluation and operational integration of economic, ecological and social indicators. This enables the students to carry out

sustainability assessments based on common and innovative new measurement concepts and indicators and to apply the results in the company.

Teaching and Learning Methods:
The module includes a lecture and an exercise. During the lecture, the content is communicated by presentations and discussions. The lectures serves to communicate the theoretical basics and terms of sustainability management including small exercises for group work. The students are encouraged to further deepen their knowledge of the proposed literature. As the highest level of competence, the lecture communicates an understanding of the evaluation of various sustainability concepts for use in operational management.
In the exercise, the students deepen the knowledge they have acquired by case studies. The content of the lectures and exercises is deepened both in small working groups and in individual work. As the highest level of competence, the exercise conveys the step-by-step development and incorporation of sustainability concepts using case studies of real and fictitious company concepts to achieve strategic and operational targets for sustainable development of the selected company.

Media:
Presentations, slide scripts, case descriptions of real and fictitious companies with sustainability management problems

Reading List:
Müller-Christ, G. (2010) Sustainable Management. Introduction into Resource Orientation and Contradictory Management Rationalities. Baden-Baden: Nomos
Schellnhuber, H. J.; Molina, M.; Stern, N.; Huber, V.; Kadner, S. (2010): Global Sustainability. 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:
Röder, Hubert; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Corporate Sustainability Management (Exercise) (Übung, 3 SWS)
Röder H [L], Röder H

Corporate Sustainability Management (Lecture) (Vorlesung, 1 SWS)
Röder H [L], Röder H
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 2023/24

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

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

Description of Examination Method:
Assessment takes the form of a written examination. 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:
End of 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 fundamental and advanced methods for modeling and solution of business problems with concepts from Operations Research (OR). Students will be introduced to using quantitative methods for planning and decision-making in companies and societies. Students will apply analytical methods of problem-solving and decision-making that is useful in the management of organizations.

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:
Hübner, Alexander; Prof. Dr. rer. pol.

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

Module Description

CS0174: Marketing for Biobased Products | Marketing for Biobased Products [MBBP]

Version of module description: Gültig ab winterterm 2023/24

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 will be in form of an oral exam. By answering questions students have to show that they have understood and can apply the thaught specific principles of the marketing of bio-based products and industrial marketing. No additional tools are allowed during oral examination with a duration of 15 minutes. In a students' project, the students demonstrate the scientific analysis and possible solutions of specific questions related to a defined topic concerning the marketing of biobased products including industrial marketing. The results of the project work will be presented (20 min; passed/non-passed) by the students with subsequent discussion with the other students and the lecturers.
In this students' project, the students demonstrate understanding of specific questions related to a defined topic concerning the marketing of bio-based products and services. Students have to show in their presentation that they can analyse, solve and answer defined problems and questions related to this topic. Participants of the course show that they have done appropriate research work and are able to present their results. By answering follow-up questions related to their presentation they show that they have learned to put their research outcome into the relevant product and market context.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic know-how related to marketing and markets of biobased products is recommended

Content:
The content of the module comprises in one part specific aspects of the marketing of biobased products and services. This part includes in particular the modification of methods and instruments of strategic marketing to this specific group of products and services (e.g. holistic character

of change in raw material basis, use of by-products and cycle approaches), the particular target groups of such products and their behavior (e.g. characteristics of related target groups, attitude-behaviour gaps), adaptations in the marketing-mix (e.g. specific benefits, labelling and identification of biobased products, avoidance of greenwashing, biomass logistics) as well as specific aspects related to the marketing of sustainability-oriented products and services (e.g. sustainable consumption and its barriers, sustainability evaluation and standards, Fair trade). Industrial marketing will be thaught in a second part of the module with a focus on specific tasks of industrial marketing, characteristics of different transaction types, specific features of transactions and service offers in the business-to-business area, as well as the combination of value chains, customer integration and service offers. Additionally, the procurement of business and state organisations will be considered with a focus on uncertainty and information as important factors in the buying process as well as concepts to analysing a buying center.
Besides, the students will use the taught methods and tools in a students' project in which actual questions and case studies related to the marketing of biobased products and services under consideration of industrial marketing will be analysed and answered.

Intended Learning Outcomes:
After attending the module, students will be able to use the instruments and methods of strategic and operational marketing related to biobased products and services thereby considering the specific aspects of industrial marketing in this context. They can deflect specific target groups for biobased products and services, analyse their behavior and derive targeted marketing strategies and their operationalization. Additionally, students can analyse the specific characteristics and challenges of sustainability-oriented products and services and are able to assess these in form of adapted marketing strategies and concepts. Students can evaluate the principles and specific tools of industrial marketing and can use these in the field of biobased products and services. Besides, students can distinguish important theoretical and practical approaches related to the procurement of business or state organisations and rate those with the specific characteristics of biobased products and services.

Teaching and Learning Methods:
The lecture will be done using Powerpoint with specifically worked out presentation scripts. In addition, published studies, scientific papers and statistical data will be integrated into the lectures. In the students' project, students use the taught methods and instruments of the marketing of biobased products and services, industrial marketing as well as their factual knowledge to analyse actual questions and cast studies related to the application fields of biobased products and services and derive adapted marketing strategies and concepts. They will present and discuss their approach and solutions with their colleagues and the lecturers.

Media:
Presentation slides, actual literature and studies, online discussion forum (all lecture materials are available via Moodle)

Reading List:
Specific literature and documents will be provided to the topics of the lectures as well as the topics that are worked on in the student projects

Responsible for Module:
Menrad, Klaus; Prof. Dr.sc.agr.

Courses (Type of course, Weekly hours per semester), Instructor:
Specific aspects of the marketing of biobased products (Vorlesung, 1 SWS)
Menrad K [L], Menrad K

Applied marketing for biobased products (Projekt, 2 SWS)
Menrad K [L], Menrad K, Stelzl B

Industrial marketing (Vorlesung, 1 SWS)
Menrad K [L], Stelzl B
For further information in this module, please click campus.tum.de or here.

Module Description

CS0228: Technology and Management of Renewable Energies in a Global Context | Technology and Management of Renewable Energies in a Global Context [REAE]

Version of module description: Gültig ab summerterm 2024

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

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

Description of Examination Method:
The exam will be in form of an oral presentation of the students (20+10 minutes; 75% of the grade) and a short report of the students' project work (max. 5 pages, not counting front page and cited literature; 25% of the grade).

In this students' project, the students demonstrate understanding of specific questions related to a defined topic concerning the technology and management of renewable energies in a global context. Students have to show in their presentation that they can analyse, solve and answer defined problems and questions related to this topic. Participants of the course show that they have done appropriate research work and are able to present their results. By answering follow-up questions related to their presentation they show that they have learned to put their research outcome into the relevant technical or country context. The presentation slides and the short report will be handed over to the lecturers and will be included in the grading.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic know-how related to specific techniques of renewable energies (e.g. solar energy, wind energy, hydropower, biomass conversion technology, geothermal energy) as well as management of energy systems either on a company or on state level.

Content:
A) Technical aspects of different forms of renewable energies (e.g. current state of technology, technical options for the future, technical bottlenecks, scale-up possibilities)
- Wind power

- Hydropower
- Photovoltaics, solarpower
- Geothermal energy
- Biomass use for energy purposes
- Biofuels, electric vehicles, E-fuels
- Hydrogen
- Other forms of renewable energies

B) Economic aspects related to defined renewable energies (e.g. cost of use/production, cost structure and development in the past, learning curves, innovation and diffusion of renewable energies)
C) Influencing factors for adoption and use of renewable energies (e.g. natural/local conditions, availability of renewable resources, technical infrastructure, user structure of energy, cost and economic factors, financing, political and regulatory issues, social acceptance, behaviour of stakeholders and people)
D) Situation and development in a specific (country) context (e.g. governance, policy goals and activities, competing factors and interests (e.g. by fossil energy use or related companies/ stakeholders), legal and regulatory stability)

Intended Learning Outcomes:
At the end of the module, students will be able to analyse and elaborate solutions for existing problems related to the technology and management of renewable energies and apply such solutions to the specific context of selected countries worldwide. They consider both the technical side as well as the economic and management dimension in order to develop integrated solutions for a specific question related to renewable energies. Additionally they take the specific context and situation (e.g. technical infrastructure and know-how, maintenance, electrical or other grids, political and regulatory rules, economic framework, company and user structure) in one or several countries or regions into account when analysing and elaborating solutions for the question on-hand. They are able to apply their knowledge to create an oral presentation and a written summary of their findings. Presented results are discussed with the audience so that students are able to defend their solution and put it in an appropriate context.

Teaching and Learning Methods:
The module is a seminar, where course participants form (preferably international) teams that investigate a given topic by autonomously doing research work and discussing results within the team. During regular meetings with the lecturers questions can be discussed, next steps are defined and (interim) results are presented. Lecturers will provide basic and background material for the students as well as actual information for the given topics that are elaborated by the student teams.

Learning activities: Literature/document research, student group project

Media:
Presentation slides, online discussion forum (all lecture materials are available via Moodle)

Reading List:
Specific literature and documents will be provided to the topics that are worked on in the student projects

Responsible for Module:
Menrad, Klaus; Prof. Dr.sc.agr.

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

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

Module Description

MGT001348: Innovation Sprint | Innovation Sprint

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 140	**Contact Hours:** 40

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

Description of Examination Method:
Combination of group and individual project assignment - final examination consists of two components, each carrying 50% of the final course grade: (1) a 5 minute group presentation plus 10 minutes Q&A and feedback at the end of the course and (2) an individual reflection paper of ca. 2,500 words.
Students will present to the class, the lecturer and the partner how the team identified an attractive opportunity in a suitable market, understood the customers' / users' needs in the process and, as a result, proposed a sustainable business model that balances people, planet and profit.

In a written reflection paper, every student will reflect upon and consolidate their individual learnings from (1) the reading package and (2) their entrepreneurial experience on three different levels - self, team and entrepreneurship.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Interest in entrepreneurship and sustainability, ability to work in a team

Content:
Supported by the reading package students will work on five intensive days in Campus only in interdisciplinary teams on a challenge from a partner and learn why and how to develop customer and user centric business ideas through applying an entrepreneurial mindset and innovative methods - always considering the triple bottom line.
Taking on an embedded view on the interrelatedness of economic, social and environmental systems, students will develop an ecosystem map to get an overview of relevant stakeholders and potential customers as well as important relationships and value streams. Input on Empathy

Research will prepare them to collect qualitative insights from potential customers and users through interviews, immersion and contextual observations.
After conducting their Empathy Research they will step by step learn how to synthesize their insights and define opportunities for sustainable innovation. With a concrete how-might-we-question they will start into ideation. Through different creativity methods they will develop and prioritize ideas and build a simple prototype. This prototype is being tested again through qualitative tests with potential customers and users. When they come back after testing they do a first iteration based on the feedback they got and derive assumptions on a potential business model. After input on pitching they will prepare slides or other material and pitch in front of the group, partner and external guests. After the pitch event they will be led through a reflection of the learnings they gained during the week. The reading package will support the transfer of these learnings.

Intended Learning Outcomes:
After participating in this module students will be able to understand and apply life-centered design principles in the early stages of an entrepreneurial process: from identifying an entrepreneurial opportunity and understanding its environmental and social impact to validating assumptions by applying qualitative research methods and interpreting data as well as using prototyping as a tool for communication and learning. They will be able to apply creativity methods, take over collective responsibility and know how to effectively communicate their business opportunities.
Taking decisions under uncertainty, ambiguity and risk in newly formed teams will foster their collaboration and communication skills and prepare them for future team work in appreciating and accommodating team members' individual personalities and boundaries.
At the same time the reading package enables students to gain a broader understanding of the methods learned in the course providing them with the ability to apply them beyond the context of innovation.

Teaching and Learning Methods:
This module relies on a combination of readings, input sessions, workshops, teamwork and individual feedback and support. While input sessions will stimulate students’ engagement with relevant tools and topics, workshops and team discussions will support the implementation of the knowledge in their projects and facilitate students’ learning of the soft and intricate aspects of adopting an entrepreneurial mindset and skills. Working on a design challenge that a partner (e.g. TUM Venture Labs) provides stimulates peer competition and allows students to directly apply what they learn in a real life setting. The reading package will strengthen students' understanding of the methods and allow them to make sense of their practical experience.

Media:
Presentations, canvas, handywork

Reading List:
Each semester students will be provided with a mandatory reading package.

Responsible for Module:
Alexy, Oliver; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Innovation Sprint (MGT001348, englisch) (Seminar, 4 SWS)
Alexy O [L], Hagleitner F
For further information in this module, please click campus.tum.de or here.

Module Description

WI000997: Marketing Entrepreneurship Lab | Marketing Entrepreneurship Lab

Version of module description: Gültig ab summerterm 2013

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 150	**Contact Hours:** 30

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

Description of Examination Method:
The grading is based on a presentation, a reflection paper and participation.
final presentation as a group (40%)
individual written reflection paper (40%)
class participation (20%)
mandatory participation of all
The seminar is on application:
https://academy.unternehmertum.de/programs/marketing-entrepreneurship-lab

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Learn from Max Wittrock, marketing expert and co-founder of jokolade and mymuesli, practical marketing and business knowledge and apply your marketing skills to real world Start-ups.
At the Marketing Entrepreneurship Lab students get the opportunity to improve their marketing knowledge and apply it to a real world challenge. Support a Start-up of your choice with a course-related project in the areas of strategic marketing, market research, product launch, etc (also possible as a team). The following topics are covered among others in the course:
• How do you create a marketing plan and decide on a strategy?
• How do you measure marketing effectiveness?
• The basics of Public Relations, Storytelling, and Social Media Marketing
• How to plan a Start-up market entry?
• How to balance budget and goals?

• The correlation of startup business models and marketing

Intended Learning Outcomes:
Have better understanding of marketing challenges and tools. Enable students to apply their theoretical knowledge about marketing and gain new capabilities in a professional and more practical direction by relating to real life startup marketing challenges.
Equip student with practical skills beyond the traditional marketing curriculum and thus close bridge students with startup founders to better equip them for working in a startup.

Teaching and Learning Methods:
lectures
group works
project-based learning
real Start-up cases

Media:
hybrid format, blocked seminar, presentation, discussion, clinic

Reading List:
will be presented at the start of the seminar

Responsible for Module:
Patzelt, Holger; Prof. Dr. rer. pol.

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

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

Module Description

WI001141: Principled Entrepreneurial Decisions | Principled Entrepreneurial Decisions [PED]

How to make game-changing decisions

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 140	**Contact Hours:** 40

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

Description of Examination Method:
Mandatory participation on all workshop days
(1) active class participation (25%)
(2) short assignement questions on cases (25%)
(3) presentation of values and principles for their company/project/future startup (25%)
(4) reflection paper, 2-3 pages, max 1.200 words (25%)
The seminar is on application:
https://academy.unternehmertum.de/programs/principled-entrepreneurial-decisions

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Application & willingness for active participation
being or becoming part of a Startup or project team
Students who are interested in Venture Capital and decision-making of founders are also welcome

Content:
This course will challenge the next generation of leaders and entrepreneurs to think critically about how their personal values and principles inform the difficult decisions they will have to make as they grow their business. The course will first equip students with frameworks to crystalize their own values and principles. Students will learn to apply their own core values. A selection of readings and case studies will provide students with tangible examples of the challenges other entrepreneurs have faced. Each class will be highly immersive, featuring conversations with entrepreneurial guest speakers and break-out sessions. Through conversations with case

protagonists and each other, students will leave the class more prepared to navigate the ethical dilemmas that they may encounter during their professional lives.

Intended Learning Outcomes:
1_students are able to brave difficult situations in the startup context
2_Enable students to begin to craft their own framework – personal and company
3_Discuss case examples (i.e. Flixbus, Konux, ProGlove, Luminovo, fernride, Reactive Robotics, Grupon, buecher.de, SevDesk, inveox, 10X, ...) and conduct exercises to help them on their journey

Teaching and Learning Methods:
lectures
group works
role plays
real Start-up cases with the founders in class
discussions

Media:
presentations
founders in class
video

Reading List:
Dalio, R. (2017). Principles: Life and work. New York, NY
Horowitz, B., & Kenerly, K. (2014). The hard thing about hard things: building a business when there are no easy answers. New York, NY: Harper Business.
More literature will be provided in class

Responsible for Module:
Patzelt, Holger; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Principled Entrepreneurial Decisions (WI001141, englisch) (Seminar, 4 SWS)
Bücken O
For further information in this module, please click campus.tum.de or here.

Life Cycle Assessment | Life Cycle Assessment

Module Description

CS0097: Advanced Environmental and Resource Economics | Advanced Environmental and Resource Economics

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
The 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:
End of Semester

(Recommended) Prerequisites:
Micro- and Macroeconomics

Content:
Many environmental issues, such as climate change, need to be considered globally. This course conveys concepts of optimal use of renewable and non-renewable resources in ex-ante viewing. In addition, the economics of water, energy markets, and natural resources such as fish and forest are deepened. Foundations of the New Institutional Economics illustrate the problem of the tragedy of common goods. Indicator systems such as Driver-Pressure-Stae-Impact-Response show the importance and complexity of environmental and sustainability measurement at national and international level.

Intended Learning Outcomes:
After attending the module, students will understand the role of renewable and non-renewable resources in the economy. Students can differentiate between the highest possible economic and sustainable return. They understand the functioning of energy and water markets. The

students gain an understanding of the New Institutional Economy, especially land ownership and the sustainable use of public goods. In addition, students understand the measurement of sustainability at the international and national level as well as the mathematical laws for the calculation of aggregated indices.

Teaching and Learning Methods:
The lecture and the seminar will be done by PowerPoint. In addition, articles from newspapers and journals are integrated into the lectures. In the seminar the students develop their own current case studies and discuss them from different perspectives based on the learned concepts and theories from the lecture. Classroom experiments are carried out for selected topics. Web lectures by internationally renowned experts and researchers will be integrated into the lecture.

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

Reading List:
Pearce, D. and R.K. Turner(1990). Economics of Natural Resources and the Environment. Johns Hopkins Univ Pr.
Tietenberg, T. and L. Lewis (2008). Environmental & Natural Resource Economics. Addison Wesley; 8 edition.

Responsible for Module:
Faße, Anja; Prof. Dr.

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

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 2023/24

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

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

Description of Examination Method:
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.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Fundamental knowledge in Life Cycle Assessment as demonstrated e.g. by the successful participation of the module Material Flow Analysis and Life Cycle Assessment or Principles of LCA.

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:
Fröhling, Magnus; Prof. Dr. rer. pol.

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

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

Materials | Werkstoffe

Module Description

CS0267: Biological Materials | Biological Materials

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor/Master	**Language:** 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:
Understanding of the course contents and their application will be tested in a written exam of 90 minutes duration. In detail, the students are required to describe the physical and chemical foundations of the formation, as well as relations between the hierarchical structure and properties, of typical biological materials. Further, the transfer of this knowledge to technological applications and to the design of novel biologically inspired materials, as covered in the course, is a test subject. Lecture notes are not permitted.

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:
Van Opdenbosch, Daniel; Dr. rer. nat.

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

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

Module Description

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:
Zollfrank, Cordt; Prof. Dr. rer. silv.

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

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

Module Description

CS0264: Polymer Processing | Polymer Processing [PolyProc]

Processing of polymers intro plastic parts

Version of module description: Gültig ab summerterm 2024

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

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

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

Repeat Examination:
Next semester

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

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

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

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

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

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

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

Courses (Type of course, Weekly hours per semester), Instructor:
Polymer Processing (Practical) (Praktikum, 1 SWS)
Zollfrank C [L], Helberg J

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

Module Description

CS0028BOK: BOKU: Wood-Industrial Processes: Wood- and Fibre-based Materials | BOKU: Wood-Industrial Processes: Wood- and Fibre-based Materials

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 50	**Self-study Hours:** 20	**Contact Hours:** 30

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

Description of Examination Method:
Written and oral
basically written; 65% needs to be reached

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Wood-based composites; first lecture will be a recapitulation.

Content:
Current Topics in Development of wood-based composites materials
Recovered Wood in wood-based composites materials
Recycling of wood-based composites materials
Testing of wood-based composites materials

Intended Learning Outcomes:
Familiarity with techniques and processes relevant in wood industrial manufacturing. Acquaintance with the processing and installation engineering to lead to solid wood products and wood-based composite materials. Get to know factors that affect manufacuring processes and product performance.

Teaching and Learning Methods:
Interactive lecture

this is a "blended learning" lecture, means half is given is given in a face-to-face classroom situation, the other half is provided through videos uploads on moodle.

Media:

Reading List:

Responsible for Module:
Rupert Wimmer rupert.wimmer@boku.ac.ar

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

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

Module Description

CS0029BOK: BOKU: Composite | BOKU: Composite

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 50	**Self-study Hours:** 20	**Contact Hours:** 30

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

Description of Examination Method:
Written and oral
In preparation for the exam, a calculation example must be solved. The information, for example, is handed over individually when registering for the exam. In the oral part of the exam, the solved example is discussed and further questions from the lecture material are asked.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Students taking the exam are expected to be familiar with the material of the lectures: natural fibers, wood physics, and natural fiber materials and technologies.

Content:
The focus of the lecture is on mechanical properties of reinforcing fibers and composites in the micro and macro range, as well as on special features of lignocellulosic fibers in composite materials.

Intended Learning Outcomes:
The course aims to provide a basic understanding of the mechanical properties of composite materials, as well as the special features of bio-based composites.

Teaching and Learning Methods:
Lecture

Media:

Reading List:

Responsible for Module:
Wolfgang Gindl-Altmutter wolfgang.gindl@boku.ac.at

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

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

Module Description

CS0030BOK: BOKU: Wood and Fibre Quality | BOKU: Wood and Fibre Quality

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 50	**Self-study Hours:** 20	**Contact Hours:** 30

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

Description of Examination Method:
Written and oral
written exam

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

Content:
1st lector: Functional cambium and wood formation
1 st lector: Wood, paper and fibre properties of interest, Advanced methods for wood and fibre characterisation
2 nd lector: Within-tree variability, conceptual models
2 nd lector: Wood structure-property relationships
3 rd lector: Links between wood / fibre / paper properties and environmental factors
3 rd lector: Improvement of wood quality, plantation forestry, Wood and fibre quality for wood composites

Intended Learning Outcomes:
Wood and fibres are products of the cambium and it they are based on cells that have passed through various phases of development. This biological process is related to wood and fibre quality, the latter being the arbitrary evaluation of an isolated piece of wood, tree part, piece of paper or any other wood derivative for a certain use. In this respect wood formation is the process, wood and fibre quality and related products are results.

The lecture introduces to basic relationships and that are important to wood and fibres originating from fast-grown plantation, regular managed forests but also from high-elevation sites. The ultimate goal is to understand biological and environmental factors that affect wood and fibre quality as well as advanced wood materials, and how to control property variability.

Teaching and Learning Methods:
multimedia-supported

Powerpoint-based lecture, group discussions, content flexibility depending on interest and interaction dynamics

Media:

Reading List:
Wimmer, R., Downes, G.M., Evans, R., French, J. (2008): Effects of site on fibre, pulp and handsheet properties of Eucalyptus globulus. Annals of Forest Science 65 (6)

Wimmer, R. (2002): Wood anatomical features in tree-rings as indicators of environmental change–a review. Dendrochronologia 20(1-2): 21-36.

Downes, G.M., Wimmer, R., Evans, R. (2002): Understanding wood formation: Gains to commercial forestry through tree-ring research. Dendrochronologia 20(1-2): 37-51.

.....more literature is discussed during the first lecture

Responsible for Module:
Rupert Wimmer rupert.wimmer@boku.ac.at

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

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

Module Description

CS0024BOK: BOKU: Engineered Wood Products | BOKU: Engineered Wood Products

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 50	**Self-study Hours:** 20	**Contact Hours:** 30

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

Description of Examination Method:
Written and oral
written preparation, oral examination interview The material of the last semester is relevant for the examination.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Prior attendance of the course 892323 materials is recommended.
Basic knowledge of mechanics or statics is required.

Content:
Selected material properties and their significance
Engineering of new materials
Material
Supporting elements and beams made of wood-based materials (BMS, LVL, LSL, PSL, I-beam)
Panel materials for load-bearing purposes
Panel materials for non-load-bearing purposes
Wood composite materials

Intended Learning Outcomes:
Students have ...
Knowledge of the properties of materials and their possible use for wood-based materials
Knowledge of the basics of material testing and material properties as well as material selection
Basics of 'engineering' (physical, economic and process aspects)

Overview of the wood-based materials available on the market, their properties and know the relationships that lead to these properties, as well as the areas of application of these materials

Teaching and Learning Methods:
Lecture

Media:

Reading List:
Powerpoint-Folien

Responsible for Module:
Johannes Konnerth johannes.konnerth@boku.ac.at

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

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

Module Description

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

From the basics to the application

Version of module description: Gültig ab summerterm 2023

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

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

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

Repeat Examination:
Next semester

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

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

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

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

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

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

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

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

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

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

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

Responsible for Module:
Ledendecker, Marc; Prof. Dr. rer. nat.

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

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

Electives Category 3 | Wahlmodule Kategorie 3

Technical Electives | Fachspezifische Wahlmodule

Module Description

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

Version of module description: Gültig ab summerterm 2024

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

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

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

Repeat Examination:
End of Semester

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

Content:
Technologies that generate analyses or predictions based on data can be found in almost all areas of our daily life (e.g. recommender systems, autonomous driving, and credit card fraud detection).

These methods are also important for analyzing biological and biomedical data, e.g. for finding novel patterns in biological data, predicting the disease state of a patient, or the 3D structure of proteins. In this course, we will learn the fundamentals of machine learning and will apply these methods to various real-world problems.
The following contents will be treated exemplarily:
- Similarity and Distance Metrics
- Data Preprocessing and Visualization
- Dimensionality Reduction (e.g., Principal Component Analysis)
- Classification (Nearest-Neighbor, Logistic Regression, Decision Trees, Support Vector Machines (SVM))
- Model Selection and Hyperparameter Optimization (Confusion Matrix and Evaluation Measures, Cross-Validation, Hyperparameter tuning techniques, Common problems such as Over- vs. Underfitting)
- Clustering (K-Means, Hierarchical Clustering)
- Regression Models (Linear Regression, Support Vector Regression)

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

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

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

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

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

Responsible for Module:
Grimm, Dominik; Prof. Dr.

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 2023/24

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

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

Description of Examination Method:
Assessment takes the form of a written examination. 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:
End of 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 fundamental and advanced methods for modeling and solution of business problems with concepts from Operations Research (OR). Students will be introduced to using quantitative methods for planning and decision-making in companies and societies. Students will apply analytical methods of problem-solving and decision-making that is useful in the management of organizations.

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:
Hübner, Alexander; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Operations Research (Vorlesung mit integrierten Übungen, 4 SWS)
Hübner A [L], Hübner A, Riesenegger L
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 2024/25

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

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

Description of Examination Method:
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 and entrepreneurship with a focus on bioeconomic questions and concepts. Building on a core understanding of the principles of innovation management and entrepreneurship, students will answer questions about the more recent innovation and entrepreneurship concepts and have the ability to explain the adapted strategies and options for new ventures firms. They will also be able to assess the relevance of technologies and resources related to the bioeconomy and the different options to design sustainable business models in the context of bioeconomic questions.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Entrepreneurship, Introduction to Innovation Management

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

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 identifiying and organising entrepreneurial ideas and innovative solutions in the context of the Bioeconomy by including broader economic, environmental and societal effects
• derive recommendations about the design and practices of innovation management and entrepreneurship and how to implement sustainable innovation
• identify and evaluate environmental 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:
The reading list is compiled from the latest contributions of relevant scientific journals, including the Academy of Management Journal, Research Policy, Strategic Management Journal, and will be made available to the students.

Responsible for Module:
Doblinger, Claudia; Prof. Dr. rer. pol. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Innovation in Bioeconomy (Lecture) (Vorlesung, 2 SWS)
Doblinger C [L], Doblinger C

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

Module Description

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

Version of module description: Gültig ab summerterm 2022

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

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

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

Repeat Examination:
End of Semester

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

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

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

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

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

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

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

Courses (Type of course, Weekly hours per semester), Instructor:
Concepts of Physics and Chemistry in Nature (Exercise) (Übung, 2 SWS)
Costa Riquelme R [L], Banda Vazquez J, Costa Riquelme R, Zieleniewska A

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

Module Description

CS0245: Advanced Electronic Spectroscopy | Advanced Electronic Spectroscopy

Version of module description: Gültig ab summerterm 2022

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

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

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

Repeat Examination:
End of Semester

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

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

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

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

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

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

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

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

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

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

Module Description

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

Version of module description: Gültig ab summerterm 2022

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

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Organic and anorganic chemistry, botany

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

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

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

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

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

Responsible for Module:
Riepl, Herbert; Prof. Dr.

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

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

Module Description

CS0263: Geothermal Energy Systems | Geothermal Energy Systems [GeoE]

Potentials of geothermal energy supply

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
Students demonstrate their knowledge and understanding of geothermal systems and their potential for energy supply in form of a written examination (90 minutes). Students deliver definitions, describe and outline relevant processes for the geothermal energy supply. Furthermore, students calculate different technical specifications and parameters based on provided practice-oriented examples.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Successful completion of the module "Basics in engineering" and "Introduction to Energy conversion and Energy economy". Knowledge and interest in Geology and Physics are valuable.

Content:
The course focuses on the variety of options for geothermal energy supply. This includes an introduction to relevant geological expert knowledge such as formation of the earth, earth’s structure, geothermal heat sources, the rock-cycle as well as mechanism of subsurface heat transport. After an introduction to deep geothermal exploration (drilling, drilling technology and related risks) the focus of the course is placed on shallow geothermal energy and use of ground-coupled heat pump systems.

This includes the design and working principle of a heat pump system and its integration in technical building equipment as well as the analysis of their ecological and economic sustainable operation on living quarter scale. The analysis is also done with regards to existing technical guidelines as well as legal boundary conditions. Practice-oriented tasks will be used to

demonstrate and critically evaluate the basic planning steps of heat pump systems and obtaining the relevant parameters. Existing and innovative geothermal exploration concepts will be analyzed and discussed against this background.

Intended Learning Outcomes:
After successful completion of the module, students acquire in-depth understanding of geothermal energy systems including relevant geological and hydrogeological processes. Students can evaluate the ecological as well as economic sustainability of geothermal heat source systems. They can test plausibility of dimensioning ground-coupled heat pump systems and understand, explain and comprehend heat transport processes and regeneration processes within the subsurface.

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 and strengthened by case studies and exercises. If applicable, the module is complemented by an excursion.

Media:
Lecture, Power Point presentation, blackboard, case examples, topics prepared and presented by participants.

Reading List:
Bayerisches Staatsministerium für Landesentwicklung und Umweltfragen (2005): Oberflächennahe Geothermie.
Bauer, M., Freeden, W., Jacobi, H., Neu, Th. (Hrsg.) (2018): Handbuch Oberflächennahe Geothermie. Springer Spektrum, 1. Auflage.
Stober, I. & Bucher, K. (2014): Geothermal Energy. Springer Spektrum, 1st edition.
Hölting, B., Coldewey, W.G. (2013): Hydrogeologie. Springer Spektrum, 8. überarbeitete Auflage.
Dassargues, A. (2018): Hydrogeology: Groundwater Science and Engineering, CRC Press, 1st edition.
Grotzinger, T. & Jordan, T. (2017): Press/Siever Allgemeine Geologie. Springer Spektrum, 7. Auflage
Grotzinger, T. & Jordan, T. (2014): Understanding Earth. W.H. Freeman & Company, 7th edition

Responsible for Module:
Vienken, Thomas; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Geothermal Energy Systems (Vorlesung mit integrierten Übungen, 4 SWS)

Vienken T [L], Vienken T
For further information in this module, please click campus.tum.de or here.

Module Description

CS0019BOK: BOKU: Forest Soil Biology | BOKU: Forest Soil Biology

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 45	**Contact Hours:** 30

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

Description of Examination Method:
The course is exam-immanent. Criteria are regular participation (at least 75%), commitment to practical work, evaluation and presentation of the results and active participation/discussion in the lectures

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
(1) Introduction to forest soil biology with a focus on biodiversity, litter degradation, humus formation and measurement methods for soil biological investigations.

(2) Excursions and method demonstration:
- Test area with automated greenhouse gas measurements as well as C, N and water balance
- Federal Research and Training Centre for Forests.

(3) Lectures: Degradation processes, influencing factors, important forest-soil organisms and their function, consequences of climate change for forest soils, online research and presentations on selected topics.

Intended Learning Outcomes:
Understanding the forest floor as a habitat for microorganisms, soil animals and plant roots. Insight into the interactions and activities of these organisms, their function and their dependence on the environment.

Teaching and Learning Methods:
Lecture with integrated exercises

Media:

Reading List:
Soil Biodiversity Atlas (freier Download unter: https://esdac.jrc.ec.europa.eu/content/atlas-soil-biodiversity)

Responsible for Module:
Andreas Schindlbacher Andreas.schindlbacher@boku.ac.at

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

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

Module Description

CS0031BOK: BOKU: Mechanical and Thermal Process Technology II | BOKU: Mechanical and Thermal Process Technology II

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 75	**Self-study Hours:** 30	**Contact Hours:** 45

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

Description of Examination Method:
written and oral

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Lecture Mechanical and Thermal Process Engineering I (MTV I; LVA 893.122)

Content:
Part A: Modern separation processes

1 Modern extraction processes

2 Processes with supercritical gases (SFE, SFC, RESS, GAS´.)

3 Membrantrennverfahren

4 Process chromatography´ preparative chromatography

Part B: Reaction Process Engineering

5 The reaction balance

6 Reaction kinetics

7 reactors

8 Dwell time and dwell time spectrum

Intended Learning Outcomes:
Based on the lecture MTV I, modern separation processes, which are of growing importance for food as well as for biotechnology, are presented in more detail. In addition, reaction process engineering is a very important area of process engineering that is systematically presented from the basics to the application, which flows into many other courses, but has so far only been presented very briefly and incoherently. Towards the end of the course, it is taught how the previously acquired knowledge, which has largely been limited to individual process steps (unit operations), can be integrated into entire processes.

Teaching and Learning Methods:
Lecture with integrated exercises

Media:

Reading List:

Responsible for Module:
Senad Novalin senad.novalin@boku.ac.at

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

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

Module Description

CS0033BOK: BOKU: Applied Measurement and Control Systems | BOKU: Applied Measurement and Control Systems

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 30	**Contact Hours:** 45

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

Description of Examination Method:
Examination immanent (attendance, cooperation, final test) Presentation of one technical term each 20 pts (1 measurement technology and 1 control technology), 2 homework of 30 pts each (1 measurement technology and 1 control task)

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basics of measurement and control technology (VO MRI I).

Content:
Practical examples from measurement and control technology. Participants learn typical problem definitions, solutions and modeling techniques.

Intended Learning Outcomes:
Students have the ability to develop solutions for typical measurement tasks.
Students can estimate measurement errors and consequential errors based on them.
Students are familiar with a modeling program (MATLAB or similar) for control systems.
Students have the competence to discuss measurement principles and their measuring ranges.
Students have the competence to discuss controller designs and their areas of application.

Teaching and Learning Methods:

Media:

Reading List:
Skript Mess- und Regeltechnik I, Teil 1 und 2; further literature will be given in the lecture.
Strohrmann G.: Meßtechnik im Chemiebetrieb, Verlag Oldenbourg.
Niebuhr J., Lindner G.: Physikalische Messtechnik mit Sensoren, Verlag Oldenbourg.
Weichert N., Wülker M.: Messtechnik und Messdatenerfassung, Verlag Oldenbourg.
Freudenberger A.: Prezessmesstechnik, Vogel Buchverlag.
Fritz W.: Regelungstechnik mit SPS, Vogel Buchverlag.

Responsible for Module:
Christoph Pfeifer Christoph.pfeifer@boku.ac.at

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

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

Module Description

CS0037BOK: BOKU: Seminar in Global Change and Ecosystems | BOKU: Seminar in Global Change and Ecosystems

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**Total Hours:** 50	**Self-study Hours:** 35	**Contact Hours:** 15

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

Description of Examination Method:
Evaluation of student presentation of a scientific publication. Evaluation of content and form of presentation; details will be announced in course. For a successful approbation, max. 2 missing dates will be tolerated.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basics in Ecology
advantageous: VO Global Change and Ecosystems

Content:
This seminar complements and extents the lecture VO 833.318 Global Change and Ecosystems. In the focus will be the following anthropogenic, global changes and their effects on organisms and ecosystem: greenhouse effect (atmospheric CO2 concentrations, warming, extreme weather events), ozone hole vs. surface ozone, increasing nitrogen deposition, land use change, decline in biodiversity, light pollution, noise pollution, plastic pollution, genetically modified organisms, pesticide use. In this seminar topics from the lecture will be complemented and deepened by student presentations. Great emphasis will be given on a critical discussion of the relevant scientific literature.

Intended Learning Outcomes:
1. Learn how to utilize relevant scientific data bases
2. Critical discussion of scientific literature and knowledge
3. Improvement of presentation skills

Teaching and Learning Methods:
Presentation of scientific articles

Media:

Reading List:

Responsible for Module:
Johann Gustav Zaller johann.zaller@boku.ac.at

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

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

Module Description

CS0038BOK: BOKU: Medicinal and Aromatic Plants | BOKU: Medicinal and Aromatic Plants

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 45	**Contact Hours:** 30

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

Description of Examination Method:
Written

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

Content:
- Definitions of medicinal and spice plants, drugs, secondary substances

- Use and economic importance of medicinal plants, spice plants and essential oils

- main cultivation areas, main crops and production data

- Trade figures and business data

- Special features of medicinal plant production and spice plant production: formation, deposition and preservation of secondary plant substances

- Quality and quality-influencing factors: genetics, breeding, variety

- morphogenetic and ontogenetic variability

- Environmental influences and plant cultivation measures

- Possible applications for agrochemicals, residue problems

- Special features of "drug production": harvesting including special harvesting methods

- Post-harvest treatment and processing in the production plant (drying plants and distillation plants)

- Discussion of the CAP guidelines (Good Agricultural Practice) for medicinal and spice plant production

- Domestication of wild plants: native species: e.B. yellow gentian, arnica, yarrow, tropical and subtropical species: e.B. Ipecacuanha, Dioscorea, Lippia sp. u.a.

Arranged according to the classic secondary substance groups essential oils, glycosides and alkaloids are discussed in the individual species:

- Botany - Ingredients - Use

- Soil and climate demands, crop rotation

- Varieties and cultivation (no-till, cultivation)

- Fertilization, care, plant protection (diseases and pests)

- Harvesting, processing, quality requirements

- Essential oily species: mint, sage, thyme, marjoram, caraway, fennel, coriander, parsley, dill, chamomile, yarrow, calendula, iris, cloves, cinnamon, nutmeg, etc.

- Glycoside-containing species: foxglove, St. John's wort, medicinal rhubarb, Sennes leaves, etc.

- Alkaloid-containing species: poppy seeds, celandine, wild cherry, stecha apple, vinca, Chinese bark, etc.

- Other: coneflower; mallow, marshmallow; Aloe u.a.

Intended Learning Outcomes:

Medicinal plants and spice plants represent a small but economically interesting group of alternative crops in terms of cultivation area. Their importance has been steadily increasing in

recent years. The aim of the course is to impart knowledge about the diversity of this plant group, including its ingredients (secondary plant substances) and its use as renewable raw materials. In addition, it is important to get to know the framework conditions for this branch of production, which requires a special infrastructure in the production plant, such as .B drying plants or extraction plants.

Based on the teaching content of the winter semester, special knowledge about cultivation, harvesting and processing of ingredients and use of the most important domestic, but also selected subtropical and tropical medicinal plant species and spice plant species is to be developed.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
Johannes Novak Johannes.novak@boku.ac.at

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

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

Module Description

CS0039BOK: BOKU: Practical Course in Energy Engineering | BOKU: Practical Course in Energy Engineering

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 65	**Contact Hours:** 10

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

Description of Examination Method:
95% arithmetic mean of the grades of the protocols. All modules have to be completed positively. 5% counts the oral performance at the introductory lectures. In the case of insufficient preparation / negative oral examination, participation in the practical course can be denied by one of the lecturers.

Minutes submitted after the deadline will be judged negative.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Basic knowledge in energy technologies, but also in the fields of mechanics, fluid mechanics, thermodynamics and measurement engineering. Following LVA's are recommended for the practical course:
1) Process engineering I and II
2) Energy and environment engineering
3) Energy engineering

Content:
The practical course focuses on various energy- related topics, like energy production, energy conversion and energy consumption. The teaching content includes experiments in the field of renewable energy production, but also exercises for energy conversion (chemical, mechanical, electrical) and efficient energy consumption. In the practical course selected exercises from this themes are executed. The practical course focuses also on sustainable energy consumption. The practical course consists of 4 stations (wind turbine test facility, high temperature heat pump test bench, engine test bench and fan test bench).

For each station, a protocol has to be prepared.

Intended Learning Outcomes:
The focus of the course objects the practical application of theoretical knowledge in the areas of process engineering, energy engineering and measurement engineering.
Practical experience in case of sustainable energy production, energy conversion and energy consumption.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
Jan Kotik jan.kotik@boku.ac.at

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

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

Module Description

CS0058BOK: BOKU: Renewable Energy Resources | BOKU: Renewable Energy Resources

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 41	**Contact Hours:** 34

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

Description of Examination Method:

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Fundamentals of physics and thermodynmacis

Content:
Energy demand and energy supply for Austria / EU. Overview of the thermodynamic fundamentals of energy conversion and introduction to the energy use (heat, electricity, fuels).
Renewable energy sources: use of solar energy for thermal use and photovoltaics, combustion calculation, thermo-chemical biomass conversion (pyrolysis, gasification, combustion, hydrothermal processes), hydropower (run-of-river, reservoir and storage power plant), geotherma energy, wind energy, biogas (anaerobic fermentation)

In the winter semester, the lecture will be offered live on the dates listed below via Zoom. Details and teaching materials can be found in the relevant BOKUlearn course.

Excursion:
It is not clear if the field trip can be provided in the winter term 2020/21. In case of cancellation a homework will be given (details can be found in the BOKUlearn course). Participation/homework contributes to the assessment of the course to 20% but is not mandatory.

Intended Learning Outcomes:
Understanding of the processes for energy utilization, competence in explaining processes and being able to compare them with one another, knowledge of thermodynamic fundamentals and physical terms

Teaching and Learning Methods:

Media:

Reading List:
Vorlesungsunterlagen werden über BOKUlearn bereitgestellt.

Responsible for Module:
Rafat Al Afif rafat.alafif@boku.ac.at

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

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

Module Description

CS0059BOK: BOKU: Applied Biocatalysis | BOKU: Applied Biocatalysis

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 50	**Contact Hours:** 25

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

Description of Examination Method:
Oral exam.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Knowledge of enzymatic reactions, engineering and (bio-)chemistry.

Content:
Applied biocatalysis" is an advanced lecture within the specialisation of “Protein engineering and technology”; in the master study programme Biotechnology H418. This course is based on the knowledge and concepts provided in engineering, chemistry, biochemistry, and molecular biology courses. The lecture starts with a general overview on enzymatic reactions, screening and engineering of enzymes for industrial applications, followed by the basics of biochemical reaction engineering (reaction and process engineering) and general criteria for industrial enzymatic processes. In the main part of the lecture specific examples of biocatalytic synthetic reactions of oxidoreductases, transferases, hydrolases, lyases, isomerases, and ligases in the various industrial sectors are introduced, analysed and probable improvements are discussed. Finally, general rules to establish a biocatalytic process will be the drawn and the strengths and weaknesses of biocatalytic reactions will be assessed.

Intended Learning Outcomes:
After successful attendance of this lecture the participants can recall the application of enzymes for the synthesis of bulk chemicals, fine chemicals and specialities. They can differentiate between different biocatalysts and know their cosubstrate requirements and necessary auxiliary reactions. They can evaluate the usefulness and performance of equilibrium reactions, enantiomeric reactions, hydrolytic reactions, reductive reactions, oxidation reactions, oxygenation reactions,

peroxidation reactions, Bayer-Villiger reactions, formation of C-C bonds, and de-/halogenation reactions. They can identify critical mechanistic limitations of reactions and rate limiting steps, and are competent to optimise reaction conditions. Finally, participants will be able to plan biocatalytic processes based on existing industrial processes and calculate performance numbers for the comparison of processes

Teaching and Learning Methods:
class lecture
Lectures equal to 1.2 ECTS will be accompanied by the idividual study of scientific articles and review materials (0.8 ECTS). For learning and the preparation to the oral exam 1 ECTS is designated.

Media:

Reading List:

Responsible for Module:
Dietmar Haltrich (BOKU)

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

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

Module Description

CS0060BOK: BOKU: Automation of Bioprocesses | BOKU: Automation of Bioprocesses

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 52	**Contact Hours:** 23

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

Description of Examination Method:
Continuous assessment

The lecture is split into a theoretical and a practical part. The evaluation criterion for the theoretical part is based on the assessment of involvement and active participation and represents 40% of the final grade.
The practical part is organized in form of teamwork practice. The task to be solved is an automation problem in industrial environment. This part contributes 60% to the final grade.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

Content:
Lecture

- Basics of automation, definitions, layout of a biotech plant

- Hardware: signal acquisition, interfacing, visualisation, systems hierarchy and ´architecture (field bus, smart sensors, actors)

- Design, system specification, contract specification

- Validation (QA) (GAMP)

Practical:

- Layout of vessel, I scheme, I/O list, layout system specification, contract specification

- DEMO process control software

Intended Learning Outcomes:
After successful completion of this course, students will be able to explain general bioprocess automation concepts and process control strategies as well as hardware and software solutions. Students will be able to select required hardware components and software solutions for bioprocess automation. They can define specification requirements.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:
Gerald Striedner (BOKU)

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

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

Module Description

CS0061BOK: BOKU: Planning and Assessment of Waste Management Systems | BOKU: Planning and Assessment of Waste Management Systems

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 75	**Self-study Hours:** 51	**Contact Hours:** 24

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

Description of Examination Method:
The total grade consists of the following individual specification:

- Participation and self-dependence, small exercises: 30%
- LCA case study elaboration: 40%
- LCA case study epresentation and discussion: 30%

Continuous assessment

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
The content of the LVA Life cycle management (813.304) or similar knowledge to Life cycle Assessment, Impact categories, Assessment Methodologies... is expected.

Content:
- Introduction to the assessment of projects and plans - strategic environmental assessment (SEA) and life cycle assessment (LCA)
- Scenario development
- Details on impact assessment
- Modelling of waste treatment technologies in life cycle assessment
- Introduction to the life cycle assessment software GaBi
- Elaboration of a LCA case study using the GaBi-Software tool

Intended Learning Outcomes:
Participants are able to assess waste management measures and to use specific soft ware tools (e.g. GaBi 6.0). They know basic methods and instruments for environmental assessment and can also evaluate them practically. The participants are able to independently calculate a life cycle assessment.
They have theoretical and practical knowledge of basic methods and tools for environmental assessment (LCA) and strategic desicion-making in waste management planning

Teaching and Learning Methods:
lecture with exercises
The lecture is very similar to the procedure in reality. First, the basic scenarios of an SEA are discussed, and the LCA case studies are based on these. The calculation and presentation of the LCA results (preparation in small groups of 2-3 people) brings all participants to a comparable level of knowledge, which is necessary for the further discussion process.
The VO units are held in blocks (4 or 6 units each), each ending with a preparation for the exercises. Furthermore, pure "exercise blocks" are also carried out, which make it easier for the students to start the exercise by the presence of the lecturer. The attendance blocks correspond to 24 hours, whereby approx. 50-55 hours should be spent on the "home exercises".

Media:

Reading List:

Responsible for Module:
Gudrun Obersteiner (BOKU)

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

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

Module Description

CS0064BOK: BOKU: Biotechnology for Sustainable Processes and Environmental Protection | BOKU: Biotechnology for Sustainable Processes and Environmental Protection

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 4	**Total Hours:** 100	**Self-study Hours:** 74	**Contact Hours:** 26

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

Description of Examination Method:
Written exam

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:

Content:
Sustainable processes based on biotechnology
Biotechnology for valorization of biomass and energy production
Enzymatic degradation and processing of lignocellulose
Enzymatic functionalization of natural and synthetic polymers
Mechanisms of enzyme catalyzed degradation of xenobiotics
Enzyme catalysed reactions in soil and water
Enzyme-remediation
Biomarkers
Biotechnological processes with photo-autotrophic microorganisms

Intended Learning Outcomes:
Knowledge about biotechnology based strategies in sustainable processes.
Understanding of the basic principles in enzyme based degradation of xenobiotics and biomass degradation in nature.
Facts about biotechnology for valorization of biomass and about bioenergy production.

Students will be familiar with general principles of biotechnological processes with photo-autotrophic microorganisms and will understand typical advantages and disadvantages.

Teaching and Learning Methods:
Classroom lecture, self-study

Media:

Reading List:

Responsible for Module:
Georg Gübitz (BOKU)

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

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

Module Description

CS0149: Renewable Resources in Medicine | Renewable Resources in Medicine

Version of module description: Gültig ab summerterm 2023

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

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

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

Repeat Examination:
Next semester

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

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

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

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

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

Media:
Presentation, script, examples, case studies

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

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

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

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

Module Description

CS0305: Research Excursion Master | Research Excursion Master

Version of module description: Gültig ab summerterm 2024

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

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

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

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

Repeat Examination:

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

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

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

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

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

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

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

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

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

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

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

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

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

Module Description

SOT86701: EuroTeQ Collider. Enhancing Connections for Sustainable Futures (MSc) | EuroTeQ Collider. Enhancing Connections for Sustainable Futures (MSc)

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
During this module, students must complete following tasks: producing a presentation that provides information on the project concept development and implementation, as well as a final report, charting the progress of their work/research over time. These assessments will evaluate a) the success of the project and b) the learning success of the students in oral and written form. Students will be graded based on the active participation in a group project (20%), a final presentation of project results (60%) and a final project report (20%). These examination requirements will assess the success of the project, but also examine the learning success of the students in oral and written form.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
This module is aimed at all students enrolled in a Bachelor or Master program at the TUM; it is thus designed as an interdisciplinary venue which brings together a range of scientific perspectives. No specific prior knowledge is required; however, its project-based character requires high levels of intrinsic motivation and the willingness to actively participate in a project.Please register for this course via TUM Online. If you have any questions or problems to register, please send an email to euroteq@ja.tum.de

Content:
"Enhancing Connections for Sustainable Futures" aims to promote an integrated approach based on three main areas: People, Nature, and Technology. In the "People" domain, the focus is on empowering and enabling communities. This involves connecting people's needs and aspirations through technology, including digital solutions, in various areas such as wellbeing,

health, culture, etc. In the "Nature" realm, the call concentrates on the conscious use of nature and the consideration of its resources. This includes examining interactions in ecosystems, safeguarding biodiversity and nature conservation, as well as utilizing renewable energies. Within the "Technology" sphere, the emphasis is on establishing efficient connections through technology, both digital and physical. This encompasses various fields such as information technology, logistics, transportation, manufacturing, communication, etc. Overall, the call aims to promote sustainable connections that enable meeting human needs, protecting the environment, and leveraging innovative technologies to achieve these goals.

The Technical University of Munich (TUM) joint forces within eight leading universities of science, technology and business to foster the European spirit in a EuroTeQ format to promote innovative engineering education across Europe. Together, we are created the first EuroTeQ Collider in 2022. Now, the journey goes into the second round. The Collider is an innovative learning format with the aim of bringing students together with vocational trainees and professionals to tackle challenges. The theme for the period 2024-2026 is “Enhancing connections for sustainable Futures”. The goal is to connect participants with different profiles and personalities to boost creativity, innovation, shared understanding, enabling participants to imagine new approaches and design disruptive solutions.

The module is a seminar that gives students the opportunity to apply their knowledge on topics related to the theme “Enhancing connections for sustainable Futures”. Within this overarching theme, we are offering challenges on three different topic-domains, namely:

• People – e.g., empowering and enabling communities, connecting people's needs and aspirations through technology (including digital solutions) in different areas such as wellbeing, health, culture, etc.
• Nature – e.g., on the conscious use of nature, taking into account environmental resources and the relationship of organisms to the environment: interactions in the ecosystem, safeguarding biodiversity and nature conservation, use of renewable energies, etc.
• Technology – e.g., efficient connections through technology, both digital and physical, in various areas such as information technology, logistics, transportation, manufacturing, communication, etc.

Within every topic domain, interdisciplinary (and international) teams of students, vocational trainees and professional learners are formed to develop solutions towards a desirable future, test and validate tools and create prototypes of their solutions. A selection of the best projects will be presented in a major high-level event, the EuroTeQaThon.

Intended Learning Outcomes:
After completion, all EuroTeQ Collider participants will be able to:
- Select and apply appropriate design, engineering and business approaches and tools to create an innovative and science-based solution to a real-life challenge.
- Develop a profound interpretation of a complex, real-life problem and its context using a system-thinking approach, considering multiple perspectives.

- Develop a problem-driven, creative, and integrative design, demonstrated by a concrete prototype that balances desirability, feasibility, and viability.
- Use disciplinary knowledge and expertise in an inter-disciplinary team to develop an innovative and scientifically sound solution in a European context.
- Communicate your ideas, at different levels of elaboration, via several mediums in an international context to a diverse set of stakeholders.
- Define and regularly reflect on personal and team development.

Teaching and Learning Methods:
A range of teaching & learning techniques will be applied:
- (pre-recorded) videos and online presentations, with podcasts and interviews, Q&A Sessions with experts
- This module is focusing on service-learning and project-based learning
- After a set of introductory sessions which provide input on the core topics but also project management, students will work on their projects in groups. Progress will be determined through project presentations during the semester, continuous feedback from the instructors, as well as peer-to-peer feedback.
- Presentational skills will be further facilitated through the requirement to present the results
- As students and professionals will work together in a joint effort, all participants will not only improve their technical skills but also enhance their soft skills such as team spirit, flexibility to work in multicultural environments, and design thinking, which are also very important in professional life.

Media:

Reading List:

Responsible for Module:
Finger, Peter; Dipl.-Ing. agr. (Univ.)

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

Research Internship (max. 10 ECTS) | Research Internship (max. 10 ECTS)

Module Description

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

Version of module description: Gültig ab summerterm 2024

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

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

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

Repeat Examination:
Next semester

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

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

internship report. In addition, a supplementary presentation of the work progress takes place. The project work can also be done with external institutions, such as companies.

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

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

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

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

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

Courses (Type of course, Weekly hours per semester), Instructor:
Research Internship Master 5 ECTS (Praktikum, 5 SWS)
Blombach B, Glawischnig E, Hädrich M, Vital S

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

Research Internship Master 5 ECTS (Forschungspraktikum, 5 SWS)
Sieber V [L], Abbas Nia A, Al-Shameri A, Arana Pena S, Dsouza Z, Fornoni E, Friedrichs J, Fuchs A, Giustino A, Grundheber J, Hofer N, Hörnschemeyer K, Hupfeld E, Kampl L, Köllen T, Liu Y, Malubhoy Z, Marosevic M, Matena F, Mayer M, Ostertag T, Raga Carbajal E, Rau M, Romeis D, Rühmann B, Scheerer J, Schieder D, Schulz M, Sieber V, Siebert D, Skopp A

Research Internship Master 5 ECTS (Forschungspraktikum, 5 SWS)
Zavrel M [L], Beerhalter D, Borger J, Dsouza V, Geisler N, Marino Jara J, Oktay I, Stegemeyer U, van der Walt H, Zavrel M

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

Module Description

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

Version of module description: Gültig ab summerterm 2024

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

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

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

Repeat Examination:
Next semester

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

Content:
Research-related work at the chairs and working groups of the TUM Campus Straubing. The students receive tasks from the research area of the supervising examiner, which they work on under guidance in the form of projects. The subject areas must be able to be assigned to the technical content of the study program. The students plan the project work largely independently under the guidance of the supervisors. The project work consists of 360 working hours, fixed in consultation with the supervisors, usually as a block internship on consecutive weeks, which can be deviated from in consultation. The project work is documented and evaluated in the form of an internship report. In addition, a supplementary presentation of the work progress takes place. The project work can also be done with external institutions, such as companies.

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

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

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

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

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

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

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

Research Internship Master 10 ECTS (Sieber) (Forschungspraktikum, 10 SWS)
Sieber V [L], Abbas Nia A, Al-Shameri A, Arana Pena S, Dsouza Z, Fornoni E, Friedrichs J, Fuchs A, Giustino A, Grundheber J, Hofer N, Hörnschemeyer K, Hupfeld E, Kampl L, Köllen T, Liu Y, Malubhoy Z, Marosevic M, Matena F, Mayer M, Ostertag T, Raga Carbajal E, Romeis D, Rühmann B, Scheerer J, Schulz M, Sieber V, Siebert D, Skopp A
For further information in this module, please click campus.tum.de or here.

General Electives | Allgemeinbildende Wahlmodule

Module Description

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

From tree to architecture – the value chain of wood

Version of module description: Gültig ab summerterm 2022

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

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

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

Length: 90 min.
Tools: dictionary

Repeat Examination:

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

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

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

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

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

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

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

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

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

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

Courses (Type of course, Weekly hours per semester), Instructor:
TUM.wood Lecture Series: Exploring the Wood Value Chain (Vorlesung, 2 SWS)
Schuster S [L], Schuster S, Seidl R, Annighöfer P, Ludwig F, Dörfler K, Weber-Blaschke G, van de Kuilen J, Zollfrank C, Benz J, Winter S, Birk S, Nagler F
For further information in this module, please click campus.tum.de or here.

SZ0003-11: Intercultural Communication | Interkulturelle Kommunikation

Module Description

SZ1102: EuroTeQ Intercultural Workshop – Intercultural competencies for working in multicultural teams | EuroTeQ Intercultural Workshop – Intercultural competencies for working in multicultural teams

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 1	**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:
1 written test 90 min. (100%)

Performance, testing the learning outcomes specified in the module description, is examined by a written test. Aids are permitted. Candidates work on tasks that focus on intercultural theories, intercultural models and other content covered in class. As part of the exam, students must prove their intercultural reflection skills by

Repeat Examination:

(Recommended) Prerequisites:
The course is especially intended for students in engineering programs, but is generally open to all TUM students. In particular, students who will be studying at a EuroTeQ partner university in the coming academic year or those, who are from partner universities and are currently studying at TUM and/or are participating in the EuroTeQ program should feel addressed. Students should envision themselves working in a European engineering context.

Content:
The workshops take place on 3-4 days in the specified period. One Workshop on Fridays / Saturdays and one on Mondays / Thursdays.
In addition to their specialist knowledge, future engineers must coordinate cross-disciplinary work and communicate with other disciplines. Accordingly, in a European job market, intercultural competencies and communication skills are required to create successful collaboration.

Intercultural agility, which is essential for studying and working in a multicultural environment, consists of a combination of knowledge about intercultural contexts and an ability to critically analyze one's own thoughts and values from an intercultural perspective After the course, students can apply intercultural models and strategies based on these models for the practical management of complex, interculturally challenging situations in university and professional settings.

Intended Learning Outcomes:
Students can recognize how intercultural factors can play a role when working in multicultural teams and how our ways of thinking, values, attitudes and our personal background influence the way we interact with others. They have acquired tools for analyzing and interpreting interculturally complex situations in a goal-oriented manner and have discourse strategies to implement these in discussions in order to facilitate mutual understanding. Students can expand their own knowledge of divergent cultural values and standards by asking purposeful and appropriate questions and they can present their own perspective.

Teaching and Learning Methods:
The module consists of a course in which the learning content is studied in a communicative and action-oriented manner using self-experience exercises, video material, critical incidents and theoretical input in individual, partner and group work. Additional self-study material is provided (for preparation and follow-up work and for deepening one's own background knowledge) for consolidation and supplementation of the classroom sessions.

Media:
Multimedia-supported teaching and learning material, also online

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
The EuroTeQ Engineer: Cultural Agility for Studying and Working in Multicultural Settings (Workshop, 1 SWS)
Elekes R, Nierhoff-King B
For further information in this module, please click campus.tum.de or here.

Module Description

WZ9470BOK: BOKU: Research Design | BOKU: Research Design

Version of module description: Gültig ab winterterm 2017/18

Module Level:	Language:	Duration:	Frequency:
Credits:* 2	**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.

TUM Project Weeks (max. 6 ECTS) | TUM Project Weeks (max. 6 ECTS)

Module Description

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

Version of module description: Gültig ab winterterm 2024/25

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

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

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

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

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

(3) Daily course exercises (30%)
In each session during the project week, you will be asked to submit a small exercise related to the day's content. This will demonstrate that you have engaged with and understood the day's topic.

Repeat Examination:
Next semester

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

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

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

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

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

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

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

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

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

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

Reading List:
Each semester students will be provided with a reading list relevant to the course.

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

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

Module Description

MGT001445: Project Week: AI and Business: Bridging Theory and Practice in Business Applications | Projektwoche: KI und Wirtschaft: Brückenschlag zwischen Theorie und Praxis bei Unternehmensanwendungen

Version of module description: Gültig ab winterterm 2024/25

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 12	**Total Hours:** 360	**Self-study Hours:** 240	**Contact Hours:** 120

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

Description of Examination Method:
Part 1 (50% of total grade):
1x 15 mins Presentation about a specific AI Application in Industry per Participant (30% of total grade)
Blog entry of 400 – 800 words per Student documenting the open challenges for a specific AI Application. Publication either on TUM CSO website or via internal Notion page, dependent of student privacy preferences. (20% of total grade)
Part 2 (50% of total grade):
1x Project Presentation and Prototype Showcase during Project week in January (max 15 min./per Participant) (50% of total grade)

Repeat Examination:

(Recommended) Prerequisites:
Basic knowledge in AI and Business Management; those who have already successfully completed the module MGT001407 cannot take this module again

Content:
“AI and Business” provides TUM students with the opportunity of gaining essential knowledge on applying AI in business scenarios, while offering students the chance to extend on this knowledge by building hands-on AI solutions for real-world business use-cases. The seminar is structured in two separate blocks. The first one is AI for Business - Essentials, and the second one is AI for Business - Advanced. AI for Business - Essentials provides students with the essential theoretical knowledge on understanding AI and how it can be enhanced for business purposes. AI for

Business – Advanced is designed as hands-on module, throughout which students collaborate in interdisciplinary teams (á 3-4 members) with partnering companies to solve real-world business problems with AI. The Advanced module cumulates in a hackathon-themed afternoon during which teams will present their solutions; with best projects having the chance of being awarded.

Intended Learning Outcomes:
The mix of theoretical foundations and practical implementation contexts of “AI and Business” is intended to enhance student’s overall AI literacy, as well as their understanding on the capabilities and limits of AI in real-world scenarios. As a consequence, the course will provide students with the necessary understanding and soft skills needed to successfully implement AI solutions in business.

Students will learn:

How to ‘think’ AI for Business in order to come up with practical and effective solutions for AI implementations in solving real-world problem settings.

How AI is already implemented in business scenarios today

How to identify pitfalls, problems, as well as cost and sustainability concerns when implementing AI

How to work effectively and on basis of scientific principles towards solving real-world problems

Critical thinking, reflection, and application of concepts and scientific findings to concrete challenges.

Presentation and Public Speaking skills, including how to prepare contents and pitches with excellence

Teaching and Learning Methods:
In this course, a combination of lectures, practical exercises, seminars, and project work is employed to achieve the intended learning outcomes. Lectures provide foundational knowledge and advanced concepts in AI and its applications in business, ensuring students have a solid theoretical base. Practical exercises allow students to apply theoretical knowledge in simulated real-world scenarios, enhancing their problem-solving skills and understanding of various perspectives.

Seminars involve in-depth discussions, reflections, and presentations. These methods encourage critical thinking, self-assessment, and peer learning. Students engage in reflective sessions to internalize the material and develop their critical thinking skills, while interactive discussions foster a deeper understanding of complex topics through collaborative learning.

Project work is a crucial component where students conduct independent research on specific topics related to AI in business. This includes preparing educational content, presenting their findings, and receiving feedback. The project work is designed to develop students' research skills, enhance their ability to create didactic materials, and improve their presentation and public speaking abilities. The iterative process of receiving and incorporating feedback ensures continuous improvement and deeper comprehension of the subject matter.

Media:
Online resources, slides, academic papers

Reading List:
Iansiti, M. (2020). Competing in the Age of AI: Strategy and Leadership When Algorithms and Networks Run the World
Brynjolfsson, E. & McAfee, A. (2017). The Business of Artificial Intelligence. Harvard Business Review. https://hbr.org/2017/07/the-business-of-artificial-intelligence
Dawes, R. M. (1979). The robust beauty of improper linear models in decision making. American psychologist, 34(7), 571.
Fleck, L., Rounding, N., & Özgül, P. (2022). Artificial Intelligence in Hiring: Friend or Foe?. ROA.
•Goldfarb & Gans (2018). Prediction Machines: The Simple Economics of Artificial Intelligence. Ingram Publisher Services. ISBN 978-1633695672.
Nestor et al. (2023). “The AI Index 2023 Annual Report,” AI Index Steering Committee, Institute for Human-Centered AI, Stanford University, Stanford, CA, April 2023.Chugunova, Marina.
Sele, Daniela (2022). We and It: An Interdisciplinary Review of the Experimental Evidence on How Humans Interact with Machines, Journal of Behavioral and Experimental Economics 99.
Suleyman, Mustafa. 2023. The Coming Wave: Technology, Power, and the Twenty-first Century's Greatest Dilemma. Crown Publishing. New York. ISBN: 978-0593593950.
• Turing, A. M. (1950). Computing Machinery and Intelligence. Mind, 59(236), 433–460. http://www.jstor.org/stable/2251299
Helmus, T. C. (2022). Artificial Intelligence, Deepfakes, and Disinformation: A Primer. RAND Corporation. http://www.jstor.org/stable/resrep42027

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

Courses (Type of course, Weekly hours per semester), Instructor:
Projektwoche: KI und Wirtschaft: Brückenschlag zwischen Theorie und Praxis bei Unternehmensanwendungen (MGT001445) (Seminar, 8 SWS)
Beckenbauer L, Capogrosso A, Welpe I
For further information in this module, please click campus.tum.de or here.

Master's Thesis | Master's Thesis

Module Description

CS0115: Master's Thesis | Master's Thesis

Version of module description: Gültig ab summerterm 2023

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 30	**Total Hours:** 900	**Self-study Hours:** 850	**Contact Hours:** 50

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

Description of Examination Method:
The module examination consists of the preparation and positive evaluation of the Master's Thesis (approximately 25 to 100 pages, depending on the topic). The overall grade is determined by the grade of the Master's Thesis.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
70 credits including all compulsory modules of the Master's program

Content:
Deepening the knowledge of current academic literature on a specific topic, which can be freely chosen from the program in consultation with the supervisor. Deepening the knowledge of appropriate research methods, as well as gaining experience in their application.

Intended Learning Outcomes:
After completing the module, students are able to derive complex scientific questions and to work on them independently using adequate scientific methods. In doing so, they demonstrate their ability to think analytically on their own. They are able to present their results conclusively, discuss them, and draw final conclusions.

Teaching and Learning Methods:
First, together with the supervisor, the topic is
the topic is narrowed down and a research question is developed. Within the framework of the Master's Thesis, the students work on this scientific question. Among other things, literature

research, theoretical models and/or empirical methods are applied. The actual teaching and learning methods depend on the respective research question and are decided jointly with the supervisor in each individual case.

Media:
Academic literature, software, etc.

Reading List:
in consultation with the supervisor

Responsible for Module:
Alle prüfungsberechtigten Dozenten/innen des Studienganges

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

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

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