TUM School of Management
Technische Universität München

Module Catalog

M.Sc. Management and Technology
TUM School of Management
Technische Universität München

www.tum.de/
www.mgt.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 239

Specialization in Management | Management-Schwerpunkt

Specialization in Management: Innovation and Entrepreneurship | Management-Schwerpunkt: Innovation and Entrepreneurship

AdvSem-IE: Advanced Seminar Innovation & Entrepreneurship | Advanced Seminar Innovation & Entrepreneurship

Module Description

WIB18812_1: Advanced Seminar Innovation & Entrepreneurship: Ideation & Venture Creation | Advanced Seminar Innovation & Entrepreneurship: Ideation & Venture Creation

Version of module description: Gültig ab summerterm 2012

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 research paper (10-15 pages, 75% of grade) and a presentation (15 min + 15 min interaction with the audience, 25% of grade). The research paper and the presentation will be conducted in groups formed in the introductory session. An assessment sheet filled in by the students and handed in with the research paper clarifies students' individual contribution to the research paper. As every student will present in the final presentation, every students' contribution is clearly identifiable and appraisable, thus, students can be graded individually. Based on the research paper it is examined to which extent students are able to elaborate complex topics in the field of entrepreneurship research. The research paper is a means to measure how students were able to understand previous academic literature in the field of entrepreneurship, how they achieved to define their own research question, collect and analyze data, and provide a relevant, novel, and interesting contribution to entrepreneurship research. A final presentation measures students' communicative competencies and proves if students are able to present their findings in a comprehensible, precise and demonstrative way as well as whether they are able to perform powerfully and professionally.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
none

Content:
The module deals with different topics within entrepreneurship research such as
- discovering entrepreneurial role models,
- psychology of entrepreneurship,
- entrepreneurial leadership,
- ideation and venture creation,
- venture growth and
- internationalization and strategic entrepreneurship.

The module prepares students for the scientific work in their master theses and provides them with deepening insights into scientific literature on entrepreneurship. Besides writing a seminar paper, this involves presenting their final results.

Intended Learning Outcomes:
Upon successful completion of this module, students will be able (1) to read and (2) understand scientific literature on the topic of entrepreneurship. Furthermore, students are able (3) to create their own research paper, i. e., identifying a relevant, interesting, and new research topic in the field of entrepreneurship, crafting a strong title, writing a compelling and strong introduction (and abstract), execute an extensive literature review and applying theory, structure the research paper meaningful, writing a strong discussion and conclusion, and complying with the ethics of writing. Additionally, they will be able (4) to present their research paper and (5) summarize their findings. Moreover, students learn how (6) to lead a scientific discussion. Finally, they (7) understand the process of scientific publication. Moreover, working in groups will provide students with communication and cooperation skills.

Teaching and Learning Methods:
The module consists of an introduction to scientific writing where the topics for each student's research paper will be decided. Topics vary and cover entrepreneurship on an individual (e.g., entrepreneurial decision making, entrepreneurial intentions), team (e.g., entrepreneurial team formation, entrepreneurial exits), or organizational level (e.g., interplay of form, structure, and embeddedness in corporate entrepreneurship). Based on their topic students prepare their research paper which they will present at the end of the module. Upon prior discussion on different research methods and how to use them, the students will identify and apply a research methodology that best addresses their identified research question, i.e., they can apply empirical research methods (qualitative or quantitative), a literature review, or conduct a conceptual paper. Furthermore, the module involves (group and/or) individual feedback sessions, where students can share their progress and receive feedback. The students are supervised by the instructors of the

module who are members the chair. Within the module the topics will be discussed after the final presentations.

Media:
MS Office, PowerPoint, Whiteboard, Flipchart

Reading List:
Hisrich, R. D./Peters, M. P./Shepherd, D. A.: Entrepreneurship, 8th edition, McGraw-Hill, 2010
Further readings will be announced at the course introduction.

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

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar Innovation & Entrepreneurship (WIB18812_1, englisch): Ideation & Venture Creation (Limited places) (Seminar, 4 SWS)
Patzelt H [L], Baur C
For further information in this module, please click campus.tum.de or here.

Module Description

WIB271011: Advanced Seminar Innovation & Entrepreneurship: Venture Growth and Internationalization | Advanced Seminar Innovation & Entrepreneurship: Venture Growth and Internationalization

Version of module description: Gültig ab winterterm 2016/17

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 seminar paper (about 10 pages; 75% of grade) and a presentation (about 25 minutes; 25% of grade). Based on the seminar paper it is examined to which extent students are able to elaborate complex topics in the field of entrepreneurship research. A final presentation proves if students are able to present their findings comprehensible, precise and demonstrative as well as are able to perform powerful and professional.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
None

Content:
The module deals with different topics within entrepreneurship research such as
• discovering entrepreneurial role models,
• psychology of entrepreneurship,
• entrepreneurial leadership,
• ideation and venture creation,
• venture growth and
• internationalization and strategic entrepreneurship.

The module prepares students for the scientific work in their master theses and provides them with deepening insights into scientific literature on entrepreneurship. Besides writing a seminar paper, this involves presenting their final results.

Intended Learning Outcomes:
Upon successful completion of this module, students will be able (1) to read and (2) understand scientific literature on the topic of entrepreneurship. Furthermore, students are able (3) to create their own scientific paper. Additionally, they will be able (4) to present their paper and (5) summarize their findings. Moreover, students learn how (6) to lead a scientific discussion. Finally, they (7) understand the process of scientific publication.

Teaching and Learning Methods:
The module consists of an introduction to scientific writing where the topics for each student's seminar paper will
be decided. Based on their topic students prepare their term paper which they will present at the end of the
module. Furthermore, the module involves (group and/or) individual feedback sessions, where students can share
their progress and receive feedback. The students are supervised by the instructors of the module who are members the chair. Within the module the topics will be discussed after the final presentations.

Media:
MS Office, PowerPoint, Whiteboard, Flipchart

Reading List:
Hisrich, R. D./Peters, M. P./Shepherd, D. A.: Entrepreneurship, 8th edition, McGraw-Hill, 2010
Further readings will be announced at the course introduction.

Responsible for Module:
Milanov, Hana; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar Innovation & Entrepreneurship (WIB271011): Venture Growth and Internationalization (Limited places) (Seminar, 4 SWS)
Milanov H [L], Rühl S
For further information in this module, please click campus.tum.de or here.

Elective Modules Innovation and Entrepreneurship | Wahlfächer Innovation and Entrepreneurship

WahlKat-IE: Catalogue of Elective Modules: Innovation & Entrepreneurship | Wahlkatalog: Innovation & Entrepreneurship

Module Description

MGT001315: European Business Law | European Business Law [EBL]

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
In the final assessment students will need to demonstrate to what extent they have met the Learning Objectives. This assessment will be held as a written exam of 60 minutes.

In this exam students will be asked theoretical questions. This will demonstrate to what extent they have memorised and understood principles of EU law. Students will also be asked to apply their knowledge to known and fictional cases. This second part demonstrates if students have developed the required legal analytical skills, as well as the ability to apply their knowledge to fact settings not discussed in the lecture and to evaluate the legal consequences.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
This module provides on overview of the laws of the European Union that are relevant for national and international businesses.

Topics covered are the institutional framework of the EU, the relationship between the EU and national law, the concept of internal market & 5 freedoms, trade law, EU competition law, and EU IP & licensing agreements.

Intended Learning Outcomes:
At the end of this course students will be able (1.) to name and understand the rules and principles of EU law which are most important for businesses, (2.) to grasp and explain the framework of EU economic policies, in particular the interaction between EU law and member state law, (3.) to identify and analyse restrains prescribed by EU law from the perspective of businesses and employees, (4.) to assess real life scenarios regarding their EU law implications and to present the results of their analyses in a written memorandum.

Teaching and Learning Methods:
The lecture will cover the theoretical aspects of the module in a discussion with the lecturer. It will also provide the opportunity to work individually or in groups on case scenarios covering issues EU law. The purpose is to repeat and to intensify the content discussed in the lecture and to review and evaluate legal issues. This application facilitates the students' abilities to present their findings in writing.

Media:
Presentations (PPT), Reader, Case studies (including model answers)

Reading List:
Chalmers, Davies & Monti, European Union Law, 3rd edition 2018, Cambridge University Press.

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

Courses (Type of course, Weekly hours per semester), Instructor:
European Business Law - Exercise (MGT001315, englisch) (Übung, 2 SWS)
Duque Lizarralde M

European Business Law (MGT001315) (Vorlesung, 2 SWS)
Duque Lizarralde M
For further information in this module, please click campus.tum.de or here.

Module Description

MGT001395: Entrepreneurship and Innovation in China | Entrepreneurship and Innovation in China

Version of module description: Gültig ab winterterm 2022/23

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:
Each seminar participant will work individually on a specific topic in the field of entrepreneurship and innovation in China. Each student will write an academic essay (75% of the overall grade), based on existing literature on entrepreneurship and innovation in China. In their essay, the students will select a Chinese company of their choice, analyze its business model, position in the market, and how they fit into China's entrepreneurship and innovation ecosystem.

Students should demonstrate that they can:
• describe and evaluate a company's business model, degree of innovation and its position in the Chinese market
• draw conclusions and identify opportunities for future research
• write an essay that follows good academic writing practices, has a clear logic, and is based on academic literature

Students will present their work (25% of the overall grade) to an academic audience.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fluency in spoken and written English

Content:
This module explores entrepreneurship and innovation in China.

Before diving into several aspects of China's entrepreneurship ecosystem and national innovation system, we learn about China and analyze its economy.

Topics covered in the module are:
- China's Economy
- Innovation and entrepreneurship theory
- China's Innovation System and the history of entrepreneurship in China
- Green growth strategy
- Innovative unicorns and the Chinese venture capital market
- Research and education System
- Made in China (MIC) 2025 and beyond
- Corporate social credit system
- Intellectual property rights system
- Artificial intelligence
- Chinese women's entrepreneurship

Intended Learning Outcomes:
After completing the seminar, students should understand how entrepreneurship and innovation work in China.

After participating in this module, students can…
• summarize the historical development of private entrepreneurship in China
• describe the current state of (women) entrepreneurship in China
• name and critically reflect relevant stakeholders in China's national innovation system
• explain the relevance of China's start-up ecosystem and Chinese private companies
• evaluate the current state of entrepreneurship and innovation in China
• analyze the latest tech, entrepreneurship, and innovation trends

Moreover, students will be able to
• search, understand, synthesize, analyze, and apply academic literature
• present and discuss their findings and conclusions to an academic audience

Teaching and Learning Methods:
• The content of the course is transmitted via lectures, supported by power-point presentations, in which the instructor provides the theoretical foundations of entrepreneurship and innovation in China
• A strong focus of the course will be on existing academic literature, which will be discussed in class
• Group work (flip chart activities etc.) in the classes will be an essential part of this module, in which students jointly and critically reflect on the theories and insights presented in the module
• The content of the module is discussed in class by openly exchanging ideas and thoughts, creating a lively learning atmosphere
• Every session contains exercises (e.g., quizzes and discussion rounds), in which students apply their learning
• Other important real-life input will be given through multi-media resources and company case studies

• For their essays, students will investigate topics within the subject of this course. Students will receive feedback from the instructor
• In a final presentation, students present the results of their seminar essays
• The instructor offers weekly seminar-related office hourse for the students (offline and online)

Media:
Powerpoint, Quizzes, Flip chart activities, Word Clouds, etc.

Reading List:
Basic literature (for detailed reading list, see Moodle):

• Atherton, Andrew, and Alex Newman (2017), Entrepreneurship in China. The Emergence of the Private Sector, Routledge, Abingdon.
• Drucker, Peter Ferdinand (2006), Innovation and Entrepreneurship, HarperBusiness, London.
• Lardy, Nicholas R. (2014), Markets Over Mao: The Rise of Private Business in China, Peterson Institute for International Economics, Washington, DC.
• Lee, Kai-Fu (2018), AI Superpowers: China, Silicon Valley, and the New World Order, Houghton Mifflin, New York.
• Lee, Kai-Fu and Qiufan Chen (2021), AI 2041. Ten Visions for our Future, WH Allen, London.
• Naughton, Barry (2007), The Chinese Economy. Transition and Growth. The MIT Press, Cambridge.
• OECD/Eurostat (2018), “Oslo Manual 2018: Guidelines for Collecting, Reporting, Using Data on Innovation, 4th Edition, The Measurement of Scientific, Technological and Innovation Activities”, OECD Publishing, Paris. https://doi.org/10.1787/24132764.
• Roberts, Huw, Josh Cowls, Jessica Morley, Mariaosaria Taddeo, Vincent Wang and Luciano Floridi (2020) “The Chinese approach to artificial intelligence: an analysis of policy, ethics, and regulation“, AI and Society, Vol. 36 No. 1, 59-77.
• Schaper, Anna-Katharina (2023), “Let’s add the land of the pandas to our research agenda. Why female entrepreneurship in China matters”, Entrepreneurship Blog of the University of Siegen, https://blogs.uni-siegen.de/modernentrepreneurship/2023/01/09/lets-add-the-land-of-the-pandas-to-our-research-agenda-why-female-entrepreneurship-in-china-matters/.
• Schaper, Anna-Katharina and Doris Fischer (2021), “Does Gender Matter for the Entrepreneurship Fairy Tale? An Analysis of Chinese Unicorn Start-ups”, CBE Research Notes 02/2021, University of Würzburg, Würzburg. https://opus.bibliothek.uni-wuerzburg.de/opus4-wuerzburg/frontdoor/deliver/index/docId/24441/file/CBE_RN02_Schaper_Fischer.pdf
• Tse, Edward (2015), China‘s Disruptors: How Alibaba, Xiaomi, Tencent, and other Companies are Changing the Rules of Business. Penguin, New York.
• World Economic Forum (WEF) (2020), The Global Competitiveness Report 2019, Geneva. http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf.
• Yueh, Linda (2019), Enterprising China. Business, Economic, and Legal Developments since 1979, Oxford University Press, Oxford.

Responsible for Module:
Richards, Melanie; Prof. Dr. oec.

Courses (Type of course, Weekly hours per semester), Instructor:
Entrepreneurship and Innovation in China (MGT001395, englisch) (Limited places) (Seminar, 4 SWS)
Schaper A
For further information in this module, please click campus.tum.de or here.

Module Description

WI001166: Entrepreneurial Prototyping | Entrepreneurial Prototyping

Version of module description: Gültig ab summerterm 2017

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 research paper (10-15 pages, 75% of grade) and a presentation (15 min + 15 min interaction with the audience, 25% of grade). The research paper and the presentation will be conducted in groups formed in the introductory session. An assessment sheet filled in by the students and handed in with the research paper clarifies students' individual contribution to the research paper. As every student will present in the final presentation, every students' contribution is clearly identifiable and appraisable, thus, students can be graded individually. Based on the research paper it is examined to which extent students are able to elaborate complex topics in the field of entrepreneurship research. The research paper is a means to measure how students were able to understand previous academic literature in the field of entrepreneurship, how they achieved to define their own research question, collect and analyze data, and provide a relevant, novel, and interesting contribution to entrepreneurship research. A final presentation measures students' communicative competencies proves if students are able to present their findings in a comprehensible, precise and demonstrative way as well as whether they are able to perform powerfully and professionally.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
The module deals with different topics within entrepreneurship research such as

- discovering entrepreneurial role models, this might include to explore
o links between role models and entrepreneurial intentions
o reasons for the choice of the entrepreneurial career

- psychology of entrepreneurship, this might include to explore
o personality dimensions of entrepreneurs
o entrepreneurial cognition
- entrepreneurial leadership, this might include to explore
o behavioral forms of leadership
o creating and managing innovative organizations
- ideation and venture creation, this might include to explore
o the process of obtaining creative ideas
o the process model of entrepreneurial venture creation
- venture growth, this might include to explore
o how new ventures grow and where growth occurs
o different impact factors on new venture growth
- internationalization and strategic entrepreneurship, this might include to explore
o the speed of entrepreneurial internationalization
o enabling forces of technology, competition, perceptions, knowledge and networks
The module provides students with deepening insights into entrepreneurship literature. Besides writing a seminar paper, this involves presenting their final results.

Intended Learning Outcomes:
Upon successful completion of this module, students will be able to read and understand related literature on the topic of entrepreneurship. Furthermore, students are able to create their own research paper. Additionally, they will be able to present their paper and summarize their findings. Moreover, students learn how to lead a discussion on their topic. Finally, they understand entrepreneurial processes.
At the end of the module, students will be able to:
- explain entrepreneurship concepts related to a specific topic.
- discuss current topics within the field of entrepreneurship.
- apply previously discussed approaches to topic specific issues within the field of entrepreneurship.
- evaluate these approaches and their outcomes.
- develop suitable approaches for specific entrepreneurship issues.

Teaching and Learning Methods:
The module consists of an introduction to scientific writing where the topics for each student's research paper will be decided. Topics vary and cover entrepreneurship on an individual (e.g., entrepreneurial decision making, entrepreneurial intentions), team (e.g., entrepreneurial team formation, entrepreneurial exits), or organizational level (e.g., interplay of form, structure, and embeddedness in corporate entrepreneurship). Based on their topic students prepare their research paper which they will present at the end of the module. Upon prior discussion on different research methods and how to use them, the students will identify and apply a research methodology that best addresses their identified research question, i.e., they can apply empirical research methods (qualitative or quantitative), a literature review, or conduct a conceptual paper. Furthermore, the module involves (group and/or) individual feedback sessions, where students can share their progress and receive feedback. The students are supervised by the instructors of the

module who are members the chair. Within the module the topics will be discussed after the final presentations.

Media:
MS Office, PowerPoint, Whiteboard, Flipchart

Reading List:
Hisrich, R. D. / Peters, M. P. / Shepherd, D. A.: Entrepreneurship, 8th edition, McGraw-Hill, 2010 (optional)
Obligatory readings will be announced at the course introduction.

Responsible for Module:
Breugst, Nicola; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Entrepreneurial Prototyping (WI001166) (Seminar, 4 SWS)
Breugst N [L], Steeghs L
For further information in this module, please click campus.tum.de or here.

Specialization in Management: Management and Marketing | Management-Schwerpunkt: Management and Marketing

AdvSem-MM: Advanced Seminar Management & Marketing | Advanced Seminar Management & Marketing

Module Description

MGT001310: Advanced Seminar in Marketing, Strategy, Leadership & Management: International Marketing Strategy | Advanced Seminar in Marketing, Strategy, Leadership & Management: International Marketing Strategy

Version of module description: Gültig ab summerterm 2022

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 coursework focuses on the preparation of a full research-based marketing plan. Such an output is made up of two interrelated parts: the initial academic-research part and the latter practical business-like part. The research part requires the use of updated qualitative and quantitative methodologies. The business-like part demonstrates the understanding of international marketing strategy and advanced marketing as a whole. The group seminar paper is based on an extensive presentation (20 to 30 slides), in accordance with the guidelines provided during this advanced seminar. The group written assignment represents 100% of the seminar's evaluation. However, selected students receive an extra grade as a bonus for their proven "in-class attitude". Detailed information that well defines "in-class attitude" is provided during the opening session of the seminar.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:

Introducing Marketing Strategy in an international context, the role of marketing in a company, the meaning of marketing management, the required elements of marketing research, the transformation of marketing analysis into marketing strategy and objectives. If time allows, it's planned to tackle the deliverables of a marketing plan being an action plan and control standards.

Intended Learning Outcomes:
At the end of the seminar students will be able to understand the dynamics of marketing strategy in an international business | to realize the role of marketing strategy as a liaison between the company's vision and its tactics | to be able to address objectives based on marketing research | to address "strategic planning" in an international context for an existing company | to improve presentation skills.

Teaching and Learning Methods:
Frontal lectures, in-class discussions, group work, self-made case studies

Media:
Frontal lectures, online supervision

Reading List:
Donnelly, J. H. & Peter J. P. (2012). Preface to Marketing Management. 13th edition, McGraw-Hill.
Lehmann, D. R.& Winer, R. S. (2009). Analysis for Marketing Planning. 7th edition, McGraw-Hill.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar Marketing, Strategy, Leadership & Management (MGT001310, englisch):
International Marketing Strategy (Limited places) (Seminar, 4 SWS)
Abramovich D, Octavianus E
For further information in this module, please click campus.tum.de or here.

Module Description

WIB08001: Advanced Seminar Marketing, Strategy, Leadership & Management: Advances in Consumer Research | Advanced Seminar Marketing, Strategy, Leadership & Management: Advances in Consumer Research

Version of module description: Gültig ab winterterm 2019/20

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:
Grading is based on an oral exam in form of an individual presentation on a study design. The presentation includes the following parts: theoretical background, hypotheses with regard to recent trends in consumer behavior, methodology for testing the hypotheses, results, discussion and conclusions. The presentation demonstrates that students are able to develop research questions and a corresponding methodology to analyze topics in current consumer research. Students are also able to critically analyze scientific papers and demonstrate their knowledge during class discussions.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge in consumer behavior theories and empirical research methods.

Content:
This seminar is designed to familiarize students with the current research areas in consumer behavior, including theories and experimental methods. The aim of the seminar is to prepare students to become active researchers in the field of consumer behavior. The focus of the seminar will be on the critical assessment of theories, research designs, and analytical approaches employed to answer specific research questions. Additionally, this course allows students to develop their own ideas regarding a more specific topic that might be of future research interest.

Intended Learning Outcomes:
At the end of the course students are able to critically analyze recent advances in consumer behavior. They know state of the art research approaches and are able to analyze the implications of current trends in consumer behavior for marketing and public policies. Students are able to apply their knowledge by developing and testing research hypotheses, drawing conclusions from the test results and providing marketing and/or policy implications.

Teaching and Learning Methods:
The module is a seminar, with the learning objectives reached through a combination of lecture, class discussion, developing a research project, and presenting a research project. Students are expected to read and discuss scientific papers on the topic. Students are also expected to develop a research methodology for testing hypotheses on recent advances in consumer behavior. The lecturer moderates in-class discussions and provides guidance and advice to students regarding their presentations.

Media:
Slides, books, scientific papers

Reading List:
There is no textbook assigned for this course. The course is mainly based on scientific articles from journals such as: Journal of Consumer Research, Journal of Marketing Research, Journal of Marketing, Journal of Consumer Psychology

Responsible for Module:
Roosen, Jutta; Prof. Dr. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar Marketing, Strategy, Leadership & Management (WIB08001): Advances in Consumer Research (Limited Places) (Seminar, 4 SWS)
Hempel C, Neubig C
For further information in this module, please click campus.tum.de or here.

Module Description

WI001278: Advanced Seminar Marketing, Strategy & Leadership: Success and failure of co-founding teams | Advanced Seminar Marketing, Strategy & Leadership: Success and failure of co-founding teams

Insights from science and practice

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 360	**Self-study Hours:** 270	**Contact Hours:** 90

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

Description of Examination Method:
The exams consist of a) summarizing and presenting current knowledge on topics of team processes and dynamics b) writing a seminar paper on a given topic in the field of co-founding team success and failure and c) written presentation of scientific knowledge for practitioners. The results of the work should show that the students
- have acquired current and relevant academic and practical literature on the topic of team processes in founding teams and are able to present them clearly and precisely
- have dealt intensively with the topic of group dynamics and entrepreneurship
- are able to process scientific content
- have presentation and communication skills that enable them to present their findings on challenging topics, in a clear and structured manner, and to demonstrate the applicability of their findings to practice.

The final grade is an average of an individual coursework (40% summary and presentation of scientific studies, 30% seminar paper on a scientific question), and a team assignment (30%, elaboration of the topic for practice).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fluent in English

Interest in the topics of team success, team dynamics, and entrepreneurship from both an academic and practical perspective

Content:
The seminar "Success and failure of co-founding teams " is an interactive learning experience that introduces students to the relevance of a successful team for the success of startups. The different facets of teamwork will be explored from a scientific and practical perspective. In the seminar, measures will be developed to make startup teams successful.

In the course of the seminar, the students will deal with one interpersonal factor each, which can influence the success of teams. The students will independently work out the current state of the art on their topic and present it to their fellow students. Together, under the guidance of the lecturers, measures are derived that increase the success of founding teams. In addition, the students learn the basics of scientific work. Students are supported through lectures by professors and invited experts, as well as through interactions with teaching assistants, in both methodological and entrepreneurial topics.

Intended Learning Outcomes:
Theory:
Students will learn the most important theories and current trends about team processes in the context of startup founders. Topics that will be covered are for example the ideal team size, influences of on creativity, diversity, personality, communication patterns, emotions or negotiation skills.
In addition, students learn the key thoughts and content of renowned entrepreneurs, VCs and movers in the entrepreneurial ecosystem.
They will learn the fundamental concepts and application areas of communication and interaction research in the context of startups, and learn to understand and present current research in these areas.

Practice:
Students will gain deep insights into the key interpersonal influences of startup success. They will be enabled to summarize the most important factors influencing interaction on team success in startups and present them for practice. In addition, interactive exercises will complement the theoretical knowledge in the form of practical experience.

Methodology:
Students will learn from both academics and practitioners about the theory and practice of startup success based on team processes. We work with academic journals, guest lecturers as well as excerpts from recent videos, podcasts, conference submissions from movers and shakers in the startup scene.

Teaching and Learning Methods:
Der Kurs besteht aus Vorträgen und von den Studierenden durchgeführten Präsentationen. Die Vorträge werden von Universitäts- und Gastdozierenden gehalten, die führende Expert:innen in den Bereichen Entrepreneurship und Interaktion sind.

Media:
Power-Point, Videos, Miro-Board, Moodle, guest speaker, team work.

Reading List:
Breugst, N., & Preller, R. (2020). Where the magic happens: Opening the black box of entrepreneurial team functioning. In The Psychology of Entrepreneurship (pp. 80-96). Routledge.
de Mol, E. (2019). What makes a successful startup team. Harvard Business Review, 21.
Knight, A. P., Greer, L. L., & De Jong, B. (2020). Start-up teams: A multidimensional conceptualization, integrative review of past research, and future research agenda. Academy of Management Annals, 14(1), 231-266.
Patzelt, H., Preller, R., & Breugst, N. (2021). Understanding the life cycles of entrepreneurial teams and their ventures: An agenda for future research. Entrepreneurship Theory and Practice, 45(5), 1119-1153.
Ivanova, S., Treffers, T., Langerak, F., & Groth, M. (2022). Holding Back or Letting Go? The Effect of Emotion Suppression on Relationship Viability in New Venture Teams. Entrepreneurship Theory and Practice, 10422587221093295.

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

Courses (Type of course, Weekly hours per semester), Instructor:
What's cooking? Founding start-ups and unicorns in real time (WI001278) (Seminar, 8 SWS)
Welpe I, Born N, Ettner J, Fiedler M, Joas R, Mehrwald P, Treffers T
For further information in this module, please click campus.tum.de or here.

Elective Modules Management & Marketing | Wahlfächer Management & Marketing

WahlKat-MM: Catalogue of Elective Modules: Management & Marketing | Wahlkatalog: Management & Marketing

Module Description

MGT001387: Risk Management | Risk Management [RMM]

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:** 105	**Contact Hours:** 45

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

Description of Examination Method:
Students are required to prepare, deliver and discuss in-class presentations. Participation in all sessions is mandatory.

The examination is reflected in a combination of both presentations:
• an interim presentation (30%)
• a final presentation including written elaboration (70%)

In the examination, students demonstrate that they
• have understood a topic assigned to them in the subject area of leadership and risk management in depth and have demonstrated the most important aspects in a way that is comprehensible to their fellow students. Emphasis is placed on linking theoretical understanding and practical application.
• have identified and prepared practical application areas for this topic in order to demonstrate how the roles of managers and employees in risk management are lived in practice, at best with direct reference to empirical results.
• Have presentation and communication skills that enable them to present their findings on this topic in a clear and structured manner and discuss the applicability of their findings to business practice.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
IMPORTANT: Available places will be allocated according to academic suitability, relevant experience and skills.
Previous experience in engineering, mathematics, statistics and probability theory, physics, management, or economics is expected; openness to social sciences is desired, as well as interest in and affinity for interdisciplinary work.

Content:
This class dives into the theory of risk management, change management and people management. It covers topics such as negotiation skills, power dynamics, organizational politics, leadership 4.0, as well as organizational design and structure. It is designed for those who want to be on top of relevant management literature while gaining insight into practical implementation.

Intended Learning Outcomes:
Students will know and understand the most important theories on leadership and risk management, current trends in research on leadership and organization, as well as their application in practice.

Students will be able to make connections between theories and empirical research findings in the field of the roles of leaders and followers in organizations regarding risk management and their application to practice. They will understand how leadership and followership works from a practitioner point of view and will be able to integrate these viewpoints with scientific theory.

Teaching and Learning Methods:
The class is designed to be very interactive, its success depends on in-class participation and interaction of the students. It is completed by keynotes from university lecturers.

lecture / discussions / readings / presentations / practitioner workshops

Media:
flipped classroom, group discussions, presentations, case studies, practical exercises, literature, script.

Reading List:
Sax, J. and Torp, S.S. (2015), "Speak up! Enhancing risk performance with enterprise risk management, leadership style and employee voice", Management Decision, Vol. 53 No. 7, pp. 1452-1468. https://doi.org/10.1108/MD-10-2014-0625

Moon, J. (2021). Effect of Emotional Intelligence and Leadership Styles on Risk Intelligent Decision Making and Risk Management. Journal of Engineering, Project & Production Management, 11(1).

Fourie, W. (2022), "Leadership and risk: a review of the literature", Leadership & Organization Development Journal, Vol. 43 No. 4, pp. 550-562. https://doi.org/10.1108/LODJ-08-2021-0394

Responsible for Module:
Welpe, Isabell M.; 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

WI001218: Patent protection | Patentschutz

Version of module description: Gültig ab summerterm 2019

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

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

Description of Examination Method:
In the final assessment students will need to demonstrate to what extent they have met the learning objectives. This assessment will be held as a written exam of 60 minutes. Students will be asked theoretical questions. This will demonstrate to what extent they have memorized and understood principles of the law of patents.
Students will also be asked to apply their knowledge to known and fictional cases. This second part demonstrates if students have developed the required legal analytical skills. Students also need to demonstrate their ability to apply their knowledge to fact settings not discussed in the lecture, and to evaluate the legal consequences.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
German Business Law 1 and 2 (WI0000027, WI0000030) or corresponding knowledge.

Content:
This module provides an introduction to basic concepts of patent law.
Topics covered are:
- subject-matter under protection and prerequisites
- proceedings before the Patent Office
- legal effects of a patent
- the inventor's right to the patent
- assignment and licensing
- enforcing a patent
- termination of a patent

Intended Learning Outcomes:
At the end of this lecture students will be able to,
1. understand the basic principles of patent law and trade secret law,
2. grasp the legal framework of business activity
3. analyse legal implications of typical business situations and to identify their options,
4. present the results of their analysis in a written memorandum.

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

Media:
Reader, presentations (PPT), cases (Including model answers)

Reading List:
Kraßer/Ann, Patenrecht

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

Courses (Type of course, Weekly hours per semester), Instructor:
Patentschutz (WI001218, WI001071) (Vorlesung, 2 SWS)
Dubov B, Fromberger M
For further information in this module, please click campus.tum.de or here.

Specialization in Management: Operations and Supply Chain Management | Management-Schwerpunkt: Operations and Supply Chain Management

AdvSem-OSCM: Advanced Seminar Operations & Supply Chain Management | Advanced Seminar Operations & Supply Chain Management

Module Description

WIB09828_2: Advanced Seminar Operations & Supply Chain Management: Operations Management | Advanced Seminar Operations & Supply Chain Management: Operations Management

Version of module description: Gültig ab winterterm 2015/16

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:
Grading is based on a seminar paper, the presentation of the respective paper as well as on active class participation. The seminar paper as well as the class participation should proof the student's acquired knowledge about the respective research topic. Furthermore, they should show whether the student managed to critically analyze the key aspects regarding their research question. By presenting their findings in front of the class, students proof that they are able to present the key aspects in a concise manner and that they are able to answer further questions on their presented findings. The seminar paper accounts for 60% of the overall grade. The presentation and participation in the discussions account for 40% of the overall grade.

Repeat Examination:

(Recommended) Prerequisites:
WI000275 "Management Science",
MA9712 "Statistik",
WI000226 "Service Operations Management"
WI000974, WI001088, "Modeling and Optimization in Operations Management"

WI000974, WI01088, "Simulation and Optimization in Operations Management"

Content:
This seminar will treat selected topics from the area of Operations Management. Operations Management is the planning and controlling of work flows. Thus, Operations Management is a central aspect of management.

Intended Learning Outcomes:
At the end of the module the students are able to understand the approaches to tackle several several operations management problems. The students are able to implement such procedures and can assess these approaches in term of effectiveness and efficiency. Finally, they are able to make sound decisions. Furthermore, the students are able to create, based on scientific publication, an independent elaboration which fulfils the formal requirements of a scientific work.

Teaching and Learning Methods:
The module consists of a seminar. The content is delivered thru presentations. The students are inspired to improve the acquired knowledge by studying the suggested literature. The students are encouraged to self practice outside the classroom. Results are presented and discussed in class. Students are supervised when they work on the several topics.

Media:
presentation slides

Reading List:
Selected literature based on the topic

Responsible for Module:
Kolisch, Rainer; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar Operations & Supply Chain Management (WIB09828_2): Operations Management (Limited places) (Seminar, 4 SWS)
Kolisch R, Kolter M
For further information in this module, please click campus.tum.de or here.

Module Description

WIB34001: Advanced Seminar Operations & Supply Chain Management: Operations Research | Advanced Seminar Operations & Supply Chain Management: Operations Research [Advanced Seminar Operations & Supply Chain Management]

Version of module description: Gültig ab winterterm 2018/19

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

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

Description of Examination Method:
The examination consists of a written seminar paper, implemented optimization or simulation models as well as an oral presentation & discussion. The seminar paper should cover 15-20 pages and is written in the style of current publications of peer-reviewed journal articles. Accompanied with the seminar paper models have to be implemented to conduct numerical analyses, which will be handed in as a digital appendix. At the end of the module students present their work in a 30 minutes presentation + 15 minutes of discussion and have to initialize and moderate the discussion on a selected paper of their fellow participants. The grading is based on the written seminar paper, the presentation and the moderation of the discussion.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students are expected to have an interest in understanding and using complex quantitative models and methods. Participants should be familiar with Operations Research techniques. It is strongly advised that interested students have previously taken part in the module "Modeling and Optimization in Operations Management."

Content:
From kidney exchange models to supply chain optimization of pharmaceuticals, there are many important applications of Operations Research (OR) in the health care sector. The use of OR in this field seeks to increase the welfare of patients and service providers, despite difficult challenges such as conflicting or multiple objectives, high uncertainty, dynamically changing environments,

and the lack of resources. In this seminar, students will investigate applications of OR methods to the unique problems faced in health care.

Intended Learning Outcomes:
Upon successful completion of this module students will be able to: (a) read, understand, and critique scientific papers, (b) deal with advanced material and original literature from the forefront of current research, (c) partake in scientific discussions, (d) give scientific presentations, (e) understand the basics of scientific writing, and (f) implement modern quantitative methods and models in related situations.

Teaching and Learning Methods:
Participants will be guided to identify the most interesting recent research papers detailing the use of OR in health care. They are expected to implement relevant models and prepare high-quality presentations and write-ups, reflecting their analyses, understanding and insights from reading the papers and related literature.

Media:
Presentation, Various forms of literature (Journal Articles, Books, Report, Conference Proceedings, etc.).

Reading List:

Responsible for Module:
Schulz, Andreas; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar Operations & Supply Chain Management (WIB34001, englisch): Operations Research (limited places) (Seminar, 4 SWS)
Schulz A [L], Schulz A
For further information in this module, please click campus.tum.de or here.

Elective Modules Operations and Supply Chain Management | Wahlfächer Operations and Supply Chain Management

WahlKat-OSCM: Catalogue of Elective Modules: Operations & Supply Chain Management | Wahlkatalog: Operations & Supply Chain Management

Module Description

WI000976: Logistics and Operations Strategy | Logistics and Operations Strategy

Version of module description: Gültig ab summerterm 2021

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:
At the end of the module a 90-minutes exam will determine the grading of the students. Students choose 3 out of 4 questions. Within each question two different competence areas are assessed. The first part of each questions covers knowledge about strategic operational and logistics concepts from the lecture. Then, in a second part, multiple quantitative methods have to be applied. They involve calculation and the analysis of results like in the exercise classes. Since calculations are to be done, a pocket calculator and a formula sheet summarizing the most relevant formulas and statistical values may be used by the students.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The module requires basic knowledge in statistics (discrete and continuous probability distributions), MS Excel and the course “Modelling, Optimization, and Simulation”, which is due to the extensive use of Mixed-Integer Linear Programming. Basic knowledge of micro-economics theory helps, but is not a must.

Content:
The module will position logistics and operations in business strategy and industrial organization. Strategic modelling and optimization approaches and tools for sourcing strategy, facility location, capacity and flexibility management will be presented and applied to problems of different industries.

Topics the module covers include:
- Competitive strategy (monopoly, simultaneous/sequential quantity competition, capacity competition, competitive locations)
- Operations strategy and Industrial Organization (supply chain configuration/operational flexibility)
- Capacity strategy (sizing and investment, timing and expansion)
- Distribution network strategy (warehouse location problem/hub- and spoke systems)
- Process technology (Make-to-order vs. Make-to-stock, factory physics)
- Operations and risk management (hedging/sourcing/inventory strategies)

Intended Learning Outcomes:
The participants will acquire knowledge on different views of logistics strategy from a market and a resource perspective and will be enabled to apply decision support tools for an effective design of global manufacturing and logistics networks. Students will be able to assess strategic problems from practice, categorize them according to the decisions involved and identify relevant solution methods to solve them. Furthermore, students are equipped with the ability to apply methodologies and techniques from theory in practical environments. After finishing the module, students will be able to evaluate innovative and complicated operations and logistics settings, such as the integration of additive manufacturing (3D printing), and create subsequent innovative solution approaches for strategic decision makers.

Teaching and Learning Methods:
The series of lectures provides students with a fundamental knowledge of concepts and methods for assessing and optimizing given problems. Exemplary problem settings are solved during exercise classes, where the content given in the lecture is applied. Optimizations using MS Excel solver and analytical calculations are the basis for a follow-up interpretation of the results. In the process, students present their work and conduct an interactive discussion with fellow students and the lecturer regarding their approach, solution and interpretation. Extending the theoretical exercises, case studies are used to let students analyse and solve real-world problems, which closes the gap between theory and practice. To give students a further glimpse into practice, guest speakers from various industries present their daily challenges and approaches to solve them. This allows students to make the connection between the theoretical concepts they have learned and the requirements in practice and provides the opportunity to discuss questions with practitioners and find problem settings that might be suitable for their final thesis.

Media:
Literature, Slides, Case Studies, Exercises

Reading List:
Van Mieghem, J.A. (2015) Operations Strategy Principles and Practice, 2nd Edition, Dynamic Ideas
Slack, N., Lewis, M. (2015), Operations Strategy, 4th Edition, Financial Times/Prentice Hall.
Belleflamme, P., Peitz, M. (2015), Industrial Organization: Markets and Strategies, 2nd Edition, Cambridge University Press.

Responsible for Module:
Minner, Stefan; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Logistics and Operations Strategy (WI000976) (Limited places) (Vorlesung mit integrierten Übungen, 4 SWS)
Minner S [L], Minner S, Lee E
For further information in this module, please click campus.tum.de or here.

Module Description

WI001034: Service and Health Care Operations Management | Service and Health Care Operations Management

Version of module description: Gültig ab summerterm 2017

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:
Grading of the module will be based on the following four assessments: At the end of the module the students have to take an open book written test of 60 minutes length. Through the module students have to hand in two assignments and have to make a 15-minute presentation followed by a 5-minute discussion. Through the test the students show that they have understood the health care operations model treated in the module. By undertaking the two assignments students demonstrate that they have acquired the capability of i) implementing a health care optimization model by using a modelling language and a solver, and of ii) implementing a health care simulation model by using a discrete event simulation. With the presentation students showcase their understanding and capability of presenting a health care problem and approach from the scientific literature so far not treated in class. The assessments are weighted with 50% (test), 15% (optimization assignment), 15% (simulation assignment) and 20% (presentation).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students should have knowledge in the mandatory undergraduate courses Mathematics (Linear Algebra), Statistics (probabilities, distributions), Management Science or Operations Research (Linear and Integer Programming), Production and Logistics or Operations Management, Programming, as well as a course in modelling and simulation such as in the elective undergraduate course “Modelling, Optimization and Simulation”.

Content:
• Legal and institutional foundations of health care operations in hospitals
• Case mix planning
• Admission planning

• Patient flow planning
• Appointment scheduling
• Emergency and assessment unit planning
• Master surgery scheduling
• Nurse rostering
• Bed assignment
• Sequencing and scheduling surgeries

Intended Learning Outcomes:
Upon completion of the module students are empowered to analyze and optimize health care processes in hospitals. In particular they 1) know the prevalent health care operations models and methods available in the literature. 2) They know how to model and solve linear programs for optimizing health care processes with off-the-shelf software. 3) They are be capable of assessing a health care system by undertaking a simulation. And 4) they are able to understand and present new approaches for health care operations available in the scientific literature. Beyond knowledge on health care operations management students know and can apply advanced OR-techniques such as goal programming and stochastic programming. Also students are capable of applying elementary operations management approaches such as scheduling, sequencing and shift scheduling relevant for operations management in general and service operations management in particular.

Teaching and Learning Methods:
Each topic will be treated based on one or two papers in scientific journals. Students are advised to prepare for the lecture by reading these papers ahead of class. In the class the health care operations problem addressed and the solution approach proposed will be presented by the lecturer and discussed with the students. For the exercise the students have to prepare applications of the approaches by solving small cases which will be discussed afterwards.
The lecture and the case based exercises will be helping students to understand the problems addressed and the solution approaches provided. In order to empower students to implement the approaches in practice students will undertake two assignments. In the first assignment students implement an optimization model with the modelling language OPL and the solver CPLEX. In the second assignments students undertake a simulation of a health care system with the software AnyLogic. The two assignments will be provided at the beginning of the module giving students some time in order to undertake them. During the time of working at the assignments students can consult the teaching assistant in the exercise for help. In order to empower students to address health care problems not treated in class, students have to select and present a problem and an associated solution approach from the literature in class.

Media:
Slides, scientific paper

Reading List:
Vissers, J. and Beech, R. (2005): Health Operations Management, Routledge, London and New York.

Responsible for Module:
Kolisch, Rainer; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Service and Health Care Operations Management (WI001034, englisch) (limited places)
(Vorlesung mit integrierten Übungen, 4 SWS)
Kolisch R, Hagspihl T
For further information in this module, please click campus.tum.de or here.

Specialization in Management: Finance and Accounting | Management-Schwerpunkt: Finance and Accounting

AdvSem-FA: Advanced Seminar Finance & Accounting | Advanced Seminar Finance & Accounting

Module Description

MGT001301: Advanced Seminar Finance & Accounting: EU FinTech Regulation | Advanced Seminar Finance & Accounting: EU FinTech Regulation

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter 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:
Students will have to write a seminar paper of about 15 pages (in groups of two). They also have to give a talk of about 20 minutes to the rest of the seminar group to demonstrate their oral and presentation skills, followed by a discussion on the topic with all students. In both parts of the examination, the abilities to analyse and to evaluate the current and/or upcoming EU regulation of different fintech areas, and to apply them in the business context, are assessed. The weighing of the grades is: 70% seminar paper and 30% presentation/discussion.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic understanding of finance and technology (fintech)

Content:
This seminar covers the most important fintech business areas and their respective regulation. Key topics will typically include:
- crowdsourcing;
- crypto assets, initial coin offerings and related business models;
- robo-advisory and the use of AI;

- digital currencies.

Intended Learning Outcomes:
Upon successful completion of this moudle, students will be able understand the main regulatory issues for running a fintech business in the EU. They will be able to identify the risks presented by regulation and assess potential way to adress these risks, including costs. They will also be able to understand the structure of EU regulation in general and present this understanding in written and in oral form. Participants will also be able to write about legal issues on an academic level.

Teaching and Learning Methods:
The course will be delivered using a mix of methods.
In the first part, the EU legal framework and the principles of academic writing will be presented in a lecture. Then the potential topics will be discussed and assigned to the participants.
In the second part, students will indepently research their topic and write a short research paper. This will be carried out under supervision by the teachers, including a feedback-loop.
In the third part, students will present their findings by giving a talk of about 20 minutes, followed by a discussion on the topic, receiving feedback from teachers and other participants.

Media:
PowerPoint, Flipchart

Reading List:
Lemma, "Fintech Regulation" (1st ed., 2020); more specific, topic-related literature will be provided at the start of the seminar

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

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar Finance & Accounting (MGT001301, englisch): EU FinTech Regulation (Limited places) (Seminar, 4 SWS)
Maume P [L], Betz A, Maume P
For further information in this module, please click campus.tum.de or here.

Module Description

WIB06771: Advanced Seminar Finance & Accounting: Cases in Finance | Advanced Seminar Finance & Accounting: Cases in Finance

Cases in Finance (WS); Theory in Finance (SS)

Version of module description: Gültig ab winterterm 2018/19

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 certificate of achievement is accomplished by the presentation of the own case solution (verbal, 40%), the discussion of another group's case solution (verbal, 10%), and the written report (50%). In the presentation, the focus lies on the structure and content of the presented case solution. In the discussion, students must challenge the case solution of another group. In the written report, students have to apply finance theory to practical issues. Hereby, a crucial point is to address the feedback of the presentation and discussion.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
This module enables students to apply finance theories and valuation methods to real questions and issues. By trying to get to the bottom of the own case study and the critical discussion of other case studies which are presented by the other teams, the seminar allows students to get in-depth knowlege of the following areas:
- Company valuation with regard to different industries and different stages of the life cycle of a company
- Company valuation in the context of Initial Public Offerings and Mergers & Acquisitions
- Problems with valuing a start-up
- Mastering crises within a firm
- Importance of the capital structure, in particular in the context of leveraged buyouts
- Long-term strategic focus of a company

- Potential synergies in mergers
- Assessment of different risk factors
- Project financing

Intended Learning Outcomes:
After completion of the module students will be able to (1) identify challenges of real-word financial cases. Moreover, they will be able to (2) operate with financial databases and carry out company valuations, event studies as well as hedging strategies. Based on these skills, students will be able to (3) analyze financial cases, (4) evaluate management decisions and (5) develop own recommendations for action. The module comprises scientific work methods and provides a direct preparation for the final thesis.

Teaching and Learning Methods:
Students are encouraged to study the literature, they are shown how to find and work with data as well as to be concerned with related topics in an initial kick-off meeting. The case study seminar is conducted as team work where specific issues are solved and discussed, at the theory seminar, students question research papers and present their findings to the group.

Media:
Books, case descriptions, academic papers, presentation slides

Reading List:
• Koller et al. (2005). Valuation – Measuring and Managing the Value of Companies. John Wiley & Sons.
• Unterstanding Asset Prices: Scientific Background zum Nobelpreis 2013 (https://www.nobelprize.org/uploads/2018/06/advanced-economicsciences2013-1.pdf)

Responsible for Module:
Kaserer, Christoph; Prof. Dr. rer. pol. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar Finance & Accounting (WIB06771): Cases in Finance (Limited places) (Seminar, 4 SWS)
Kaserer C, Treßel V
For further information in this module, please click campus.tum.de or here.

Fa-WahlKat: Elective Modules Finance and Accounting | Wahlfächer Finance and Accounting

WahlKat-FA: Catalogue of Elective Modules: Finance and Accounting | Wahlkatalog: Finance & Accounting

Module Description

MGT001315: European Business Law | European Business Law [EBL]

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
In the final assessment students will need to demonstrate to what extent they have met the Learning Objectives. This assessment will be held as a written exam of 60 minutes.

In this exam students will be asked theoretical questions. This will demonstrate to what extent they have memorised and understood principles of EU law. Students will also be asked to apply their knowledge to known and fictional cases. This second part demonstrates if students have developed the required legal analytical skills, as well as the ability to apply their knowledge to fact settings not discussed in the lecture and to evaluate the legal consequences.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
This module provides on overview of the laws of the European Union that are relevant for national and international businesses.

Topics covered are the institutional framework of the EU, the relationship between the EU and national law, the concept of internal market & 5 freedoms, trade law, EU competition law, and EU IP & licensing agreements.

Intended Learning Outcomes:
At the end of this course students will be able (1.) to name and understand the rules and principles of EU law which are most important for businesses, (2.) to grasp and explain the framework of EU economic policies, in particular the interaction between EU law and member state law, (3.) to identify and analyse restrains prescribed by EU law from the perspective of businesses and employees, (4.) to assess real life scenarios regarding their EU law implications and to present the results of their analyses in a written memorandum.

Teaching and Learning Methods:
The lecture will cover the theoretical aspects of the module in a discussion with the lecturer. It will also provide the opportunity to work individually or in groups on case scenarios covering issues EU law. The purpose is to repeat and to intensify the content discussed in the lecture and to review and evaluate legal issues. This application facilitates the students' abilities to present their findings in writing.

Media:
Presentations (PPT), Reader, Case studies (including model answers)

Reading List:
Chalmers, Davies & Monti, European Union Law, 3rd edition 2018, Cambridge University Press.

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

Courses (Type of course, Weekly hours per semester), Instructor:
European Business Law - Exercise (MGT001315, englisch) (Übung, 2 SWS)
Duque Lizarralde M

European Business Law (MGT001315) (Vorlesung, 2 SWS)
Duque Lizarralde M
For further information in this module, please click campus.tum.de or here.

Module Description

WIB23006: Advanced Seminar Finance & Accounting: Strategy Planning and Steering | Advanced Seminar Finance & Accounting: Strategy Planning and Steering

Strategy Planning & Steering

Version of module description: Gültig ab winterterm 2016/17

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

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

Description of Examination Method:
Grading is based on a seminar paper (max. 16 pages, 40%) and the presentations (10 minutes + 15 minutes discussion, 60%) of the elaborated case studies. The seminar paper should reveal the student's acquired knowledge about the respective seminar topic. Furthermore, the students should critically analyze the key aspects regarding their seminar topic. By presenting their findings in front of the class, students proof that they are able to present the key aspects in a concise manner and that they are able to answer further questions on their presented findings. The paper and the presentations will be processed in teams of 3-4 students, whereas the individual part of each student has to be clearly identifiable.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Working knowledge of the mandatory basic business courses

Content:
The module offers participants insights into the interaction of strategy, planning and steering processes and gives them the opportunity to examine one topic in more detail. Emphasis is put on the transfer and the adaptation of different models and philosophies onto specific industries and companies. The module may serve as a starting point for further research, but also prepares participants for issues they are likely to face in their professional lives. Goal of the module is to develop a strategy plan and a business model for a company as well as a steering tool.

Intended Learning Outcomes:
After completing this module, students will have an advanced knowledge of the module's core topic. In particular, they will be able to write a seminar paper in an academic way, compile a literature review, and structure their work. Furthermore, students will be able to present their results, answer related questions, and to lead a discussion.

Teaching and Learning Methods:
This module is a seminar.
- working with Case studies
- working with academic papers

Media:
Books, case descriptions, academic papers, presentation slides

Reading List:
• Müller-Stewens, G., Lechner, C.(2005): Strategisches Management. Wie strategische Initiativen zu Wandel führen, 3. Auflage, Stuttgart: Schäffer-Poeschel Verlag
• Ku#nzel, H. (2016). Erfolgsfaktor Performance Management: Leistungsbereitschaft einer aufgekla#rten Generation. Berlin: Springer Gabler

Responsible for Module:
Mohnen, Alwine; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar Finance & Accounting (WIB23006): Strategy Planning & Steering (Seminar, 4 SWS)
Mohnen A, Stäglich J (Mitterer N)
For further information in this module, please click campus.tum.de or here.

Module Description

WIB33002: Venture Capital Lab | Venture Capital Lab

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 145	**Contact Hours:** 35

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

Description of Examination Method:
Grading is based on a written research paper (15-20 pages) (50%), whereas the results and conclusions of the research paper need to be presented (30 min.) (50%) in front of the class. This should prove whether the student managed to critically analyze, quantify and conclude key aspects regarding the commerzialisation of business ideas based on a scientific approach. By presenting their findings in front of the class, students prove that they are able to present the key aspects in a concise manner and that they are able to answer further questions on their presented findings.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in finance and/or technology and innovation management, e.g. through courses such as "Start-up financing", "Technology and Innovation Management: Introduction" or "Advanced Technology and Innovation Management"

Content:
The module consists of a seminar. The format and its key elements (i.e. trend scouting, technology screening & scouting, business analysis of entrepreneurial firms, entrepreneurial value chain) will be discussed in the first phase. Each semester participants of the EF-Lab will analyze a different, pre-specified market or technology, for example 3D-printing, Mobile Health Solutions or FinTech. Analyzing the respective market will be done during the second phase.

Intended Learning Outcomes:
After having successfully finished this module, students (1) can recall how to commercialize business ideas and to realistically quantify their potential (for profit). Furthermore, students (2) can evaluate the market potential and profitability of a business model from the perspective of an entrepreneur. They are able (3) to analyze and (4) forecast financial key performance

indicator, which prepares them for working in the equity investment industry, in particular as growth companies' stocks equity analyst or in a venture capital or private equity firm. Moreover, students will be able (5) to present and (6) discuss their findings in a way that satisfies both, academic as well as industry standards.

Teaching and Learning Methods:
Organizationally, the course consists of two phases. It starts with an initial block seminar, in which students gain insights into the pre-specified market or technology covered and learn more about the tools and techniques to be used subsequently. In the second stage over the following weeks, the analysis phase, participants build small teams and apply what they have learned in the first stage to specific segments of the market/technology specified. Each group will produce a written market/technology report on a specific segment of the overall market. The EF-Lab concludes with students' presentations of their group work.

Media:
Slides, whiteboard, books, scientific papers.

Reading List:
Feld, B. / Mendelson, J. (2016): Venture Deals. Wiley.
Ramsinghani, M. (2014): The Business of Venture Capital, Wiley

Responsible for Module:
Braun, Reiner; Prof. Dr. rer. oec.

Courses (Type of course, Weekly hours per semester), Instructor:
Venture Capital Lab (WIB33002) (Limited places) (Seminar, 4 SWS)
Braun R [L], Barth S
For further information in this module, please click campus.tum.de or here.

Module Description

WI001284: Behavioral Economics meet real world challenges | Behavioral Economics meet real world challenges [Behavioral Economics_Projectrally]

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
The examination consists of the presentation (written project report of 10 pages) of the project work comprising a description of the relevant project planning steps required as well as a meaningful use of behaviroal economic instruments to bridge people´s attitude behavior gap. An oral group presentation of the results will also be required. The project work shall validate the student´s ability to transform their ideas into a project proposal including a corresponding work breakdown structure and a communication strategy, while the presentation shall allow to assess the ability to present a project idea to an audience, and to conduct a discussion about the presented issues.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
The module offers participants an overview of current issues in behavioral economics and their application on current societal or environmental challenges and gives them the opportunity to examine one topic in more detail. The module may serve as starting point for further research, but also prepares participants for issues they are likely to face in their professional lives. Emphasis is put on aspects of choice architecture, social preferences, nudging/green nudges, herding, and further phenomena of behavioral economics and their application on a real world case. The topics are typically related to human behavior in an economic context and potential behavioral interventions.

Intended Learning Outcomes:
At the end of the module, students are able to develop a detailed project plan and to understand related communication processes as well as apply principles and tools of behavioral economics. They can present their results to specific target audiences in an organized manner. Additionally, they can organize ideas effectively and communicate them in a well-developed written report. Furthermore, students are able to understand the needs of different stakeholder groups touched by societal or environmental challenges and to apply techniques to avoid miscommunication in project management rooted in misunderstandings between different actors being involved in the project. After attending the module students are also able to analyze and evaluate basic principles of management. They can deduct recommendations and develop company-specific decisions in management. Furthermore students know how to assess pros and cons regarding the applicability and impacts on corporate management.

Teaching and Learning Methods:
In an introductory session, the topic of the current project is introduced and elaborated in detail. The introduction will also introduce the relevant behavioral economics and project management knowledge. Knowledge and skills are imparted by lectures, flipped classroom teaching, individual and group project work, peer discussions, and individual coaching sessions; the learning methods are definition and solving of problems, collaborative work, group discussions, prepare and hold presentations, report writing.

Media:
Books, case descriptions, academic papers, presentation slides, online resources

Reading List:
tbd

Responsible for Module:
Mohnen, Alwine; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Behavioral Economics meet real world challenges: An interdisciplinary project rally (WI001284) (Seminar, 4 SWS)
Konieczny K, Wayand M
For further information in this module, please click campus.tum.de or here.

Specialization in Management: Economics and Econometrics | Management-Schwerpunkt: Economics and Econometrics

AdvSem-EE: Advanced Seminar Economics & Econometrics | Advanced Seminar Economics & Econometrics

Module Description

WI001250: Advanced Seminar Economics, Policy & Econometrics: Current Topics in Value Chain Economics | Advanced Seminar Economics, Policy & Econometrics: Current Topics in Value Chain Economics [Seminar VCE]

Version of module description: Gültig ab summerterm 2020

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:
Grading will be based on a project with presentation in form of teamwork. The results of the project are summarized in a written report (12-15 pages, 50% of the grade) and reported in an oral presentation (20 min., 50% of the grade) with subsequent discussion.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge in microeconomics

Content:
The module deals with the economic performance, efficiency, sustainability and fairness of food value chains from an applied perspective. Key topics of the module may thereby include: Coordination of supply chains (business relationships among different actors in supply chains: role of contracts, hybrid organizations, producer organizations etc. Role of small-size farms and farmers in local and global supply chains Market and bargaining power, (un)fair business practices Role of food labels and certification Current trends and their economic implications. Examples are

the increasing relevance of regional/local products; healthy products; dietary trends. European-level and national-level policies affecting agro-food value chains.

Intended Learning Outcomes:
After successful completion of this module, students will have in-depth knowledge on how to conceptualize, plan and conduct a research project in food (and related) value chain and their governance. Moreover, students will be able to i) identify and structure a research topic, ii) procure and screen relevant literature, iii) develop a study instrument; iv) write a scientific research report, iv) present their findings in front of their peers as well as v) entering and moderating a scientific discussion on their topic. The module thereby prepares students for the scientific analyses conducted in their master theses

Teaching and Learning Methods:
The module is a seminar and provides students with in-depth knowledge in the economics of value chains, with an emphasis on agro-food value chains. The seminar starts with a series of introductory lectures surrounding one or more selected state-of-the-art and policy-relevant topics. Priorities are given to topical topics for which the interest and involvement of external institutions (e.g., the European Union’s Joint Research Centre) can be insured. Activities are typically carried out in parallel in coordination with other universities and students will have the opportunity to collaborate and exchange with students from those universities. Guided by the instructor(s) through the entire process, students will work alone and/or in groups to plan and carry out a topic-specific research project (e.g., development of a survey instrument, collection of data/information). Activities will include also literature search and scientific writing of a project report.

Media:
PowerPoint presentations, economic textbooks, scientific articles

Reading List:
Allain, M. L., & Chambolle, C. (2005). Loss-leaders banning laws as vertical restraints. Journal of Agricultural & Food Industrial Organization, 3(1).
Bonnet, C., & Dubois, P. (2010). Inference on vertical contracts between manufacturers and retailers allowing for nonlinear pricing and resale price maintenance. The RAND Journal of Economics, 41(1), 139-164.
Chauve, P., Parera, A., & Renckens, A. (2014). Agriculture, Food and Competition Law: Moving the Borders. Journal of European Competition Law & Practice, 5(5), 304-313.
European Parliament (2009) Fair revenues for farmers: A better functioning food supply chain in Europe, Resolution (2009/2237(INI))
Maertens, M., & Swinnen, J. F. (2008). Standards as barriers and catalysts for trade, growth and poverty reduction. Journal of International Agricultural Trade and Development, 4(1), 47-61.
Maglaras, G., Bourlakis, M., & Fotopoulos, C. (2015). Power-imbalanced relationships in the dyadic food chain: An empirical investigation of retailers' commercial practices with suppliers. Industrial Marketing Management, 48, 187-201.

Menapace, Luisa, and GianCarlo Moschini. "Quality certification by geographical indications, trademarks and firm reputation." European Review of Agricultural Economics 39.4 (2012): 539-566.
Ola, Oreoluwa, and Luisa Menapace. "A meta-analysis understanding smallholder entry into high-value markets." World Development 135 (2020): 105079.
Ola, Oreoluwa, and Luisa Menapace. "Revisiting constraints to smallholder participation in high# value markets: A best#worst scaling approach." Agricultural Economics (2020).Ronnen, U. (1991). Minimum quality standards, fixed costs, and competition. The RAND Journal of economics, 490-504.
Russo, C., Perito, M. A., & Di Fonzo, A. (2014). Using private food safety standards to manage complexity: a moral hazard perspective. Agricultural Economics Review, 15(389-2016-23512), 113-127.
Russo, C., Perito, M. A., & Di Fonzo, A. (2017). 8. The apparent paradox of unadvertised private food safety standards1. It's a jungle out there–the strange animals of economic organization in agri-food value chains, 161.
Saitone, T. L. (2012). Are Minimum Quality Standards Imposed by Federal Marketing Orders Acting as Nontariff Trade Barriers?. Agribusiness, 28(4), 483-504.
Sexton R. (2017). Unfair Trading Practices in the Food Supply Chain: Defining the problem and the policy issues. In Marcantonio, F. Di and P. Ciaian (Editors), Unfair trading practices in the food supply chain: A literature review on methodologies, impacts and regulatory aspects, European Commission, Joint Research Centre.
Vaqué, L. G. (2014). Unfair Practices in the Food Supply Chain: A Cause for Concern in the European Union's Internal Market which Requires an Effective Harmonising Solution. European Food and Feed Law Review, 9(5), 293-301.
Von Schlippenbach, V., & Teichmann, I. (2012). The strategic use of private quality standards in food supply chains. American Journal of Agricultural Economics, 94(5), 1189-1201.

Responsible for Module:
Menapace, Luisa; Prof. Ph.D.

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

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

Module Description

WI001282: Advanced Seminar Economics, Policy & Econometrics: Economics of Science | Advanced Seminar Economics, Policy & Econometrics: Economics of Science

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:** 180	**Contact Hours:**

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

Description of Examination Method:
The coursework involves reading of scientific papers and further academic elaboration and research on a specific topic related to the seminar's overall theme.
The students will be asked to
(i) summarize the key insights on one of the seminar topics in a written essay (seminar paper), and to
(ii) present their finding in class in a 20 minutes presentation.
The examination will consist of these two parts: (i) written seminar paper, and (ii) oral in-class presentation. Active class room participation is expected during the entire course of the seminar.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Principles of Economics

Content:
Universities and scientific research institutions are important agents in knowledge-based economies. They generate scientific knowledge that spills over to the broader economy, for instance, by allowing firms to use scientific knowledge for their innovation activities. The growing importance of science-based industries puts additional emphasis on the question how scientific knowledge is generated and whether governments can impact knowledge generation through governance tools. This seminar will therefore cover key topics within the Economics of Science such as:
1) Sources of scientific discovery and invention: human capital and research funding;
2) Incentives and drivers for scientific progress;

3) Academic entrepreneurship and industry science-collaboration;
4) The diffusion of scientific knowledge;
5) Science and regional development.

Intended Learning Outcomes:
Students will learn the key concepts in the research field of Economics of Science. The goal is to understand and reflect upon the role of scientific research and the diffusion of its results for economic outcomes such as innovation & technological progress, (regional) economic development and growth. The seminar uses advanced original economic research articles for illustrating these concepts and for deriving fundamental insights.

Teaching and Learning Methods:
Students will self-study selected articles related to the assigned topic and will be coached throughout the semester by the instructor. A key learning objective is the ability to read, understand and reflect upon scientific articles on the seminar topic. Students will perform their own research of reference materials, define a specific research question for their seminar paper, identify potential gaps in the academic literature and public understanding of the focal topic, and learn to derive policy suggestions based on the scientific evidence.

A further learning objective is the communication of the key insights to the seminar group, i.e. to other students. Students are encouraged to form groups and work in groups.

Media:
Teaching will be in the form of a lecture and seminar presentations.

Reading List:
Core text book: Paula E. Stephan (2012). How Economics Shapes Science (Vol. 1). Cambridge, MA: Harvard University Press.

Responsible for Module:
Hottenrott, Hanna; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar Economics, Policy & Econometrics (WI001282, englisch): Economics of Science (Limited places) (Seminar, 4 SWS)
Hottenrott H, Schaper T
For further information in this module, please click campus.tum.de or here.

Elective Modules Economics & Econometrics | Wahlfächer Economics & Econometrics

WahlKat-EE: Catalogue of Elective Modules: Economics & Econometrics | Wahlkatalog: Economics & Econometrics

Module Description

WI001221: International Trade I | International Trade I [IT I]

Foundations of the International Economics

Version of module description: Gültig ab summerterm 2019

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 60	**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 the case study
academic elaboration, including a written essay (grade contribution 60%) and in-class presentation (grade contribution 40%). The essay will reveal students' understanding of theories and methods, and their ability to apply those to real-world problems.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Microeconomics 1

Content:
Lectures cover international economics theory that underpins the understanding of international trade fundamentals: why countries trade, what determines trade patterns, and what the implications of trade are. The course introduces theoretical models along with the empirical studies helping students develop capabilities to participate in discussions related to international trade, formulate own questions and opinions, and analyze real-world developments.

Intended Learning Outcomes:
Upon successful completion students learn the key terms

and concepts relevant in international trade discussions and will be able to apply theoretical models to analyze empirical data, such as trade statistics. Students will also be equipped to continue their education on international trade policy, foreign direct investments, international supply chains and multinational firms.

Teaching and Learning Methods:
Theoretical model development, discussion of their
implementation, problem solutions, and real-world examples analysis

Media:

Reading List:
1. International Economics Theory & Policy
by Paul R. Krugman, Maurice Obstfeld, Marc J. Melitz, Pearson, 2017
2. International Trade: Theory and Evidence by James Markusen, James Melvin, William Kaempfer, and Keith Maskus, McGraw Hill, Boston, 1995.

Responsible for Module:
Ikonnikova, Svetlana; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
International Trade I (WI001221) (Vorlesung, 2 SWS)
Berdysheva S, Ikonnikova S

International Trade I - Exercise (WI001221) (Übung, 2 SWS)
Berdysheva S, Ikonnikova S
For further information in this module, please click campus.tum.de or here.

Module Description

WI001226: International Trade II | International Trade II [IT II]

International Economics: Trade Policy and Multinational Firms

Version of module description: Gültig ab winterterm 2019/20

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

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

Description of Examination Method:
The examination consists of a presentation of the case study results, including a written report and in-class presentation. The reports are a means to assess the students' understanding of theories and methods, their ability to apply them to real-world problems.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Microeconomics 1

Content:
This course, built on the concepts and models of international trade theory, introduces the major instruments and rational for the international trade policy, examines the implications of such policies for international organizations, multinational firms, and capital allocation or investments. The lectures will be complemented by seminars or tutorials, discussing the implementations of theoretical models for case studies and empirical research.

Intended Learning Outcomes:
Upon successful completion students will be able to understand and participate in international trade policy debates, analyze strategies of multinational firms, and development of international supply chains.

Teaching and Learning Methods:
The lectures review the advances in international trade theory, models to understand and analyze international trade policies and its implications. Special attention will be given to the behavior and impact of trade on multinational firms international, international trade wars, link between trade

and endogenous growth. The course develops analytical instruments required to understand and analyze empirical evidence and real-world problems.

Media:

Reading List:
• International Economics Theory & Policy by Paul R. Krugman, Maurice Obstfeld, Marc J. Melitz, Pearson, 2017.
• International Trade: Theory and Evidence by James Markusen, James Melvin, William Kaempfer, and Keith Maskus, McGraw Hill, Boston, 1995.
• Advanced International Trade by Robert C. Feenstra, Princeton University Press, Princeton, 2004.
• International Trade Theory: Capital, Knowledge, Economic Structure, Money, and Prices over Time by Wei-Bin Zhang, Springer-Verlag, 2008.
• Handbook of International Trade, edited by E. Kwan Choi and James Harrigan, Blackwell, 2003.

Responsible for Module:
Ikonnikova, Svetlana; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
International Trade II (WI001226, englisch) Exercise (Übung, 2 SWS)
Ikonnikova S, Li G

International Trade II (WI001226, englisch) (Vorlesung, 2 SWS)
Ikonnikova S, Li G
For further information in this module, please click campus.tum.de or here.

Module Description

WI001281: The Economics of Firm Competition | The Economics of Firm Competition [EconFirms]

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:
A written examination is deemed appropriate to test the ability of students to analyse static and dynamic strategic behaviour of firms. Specifically, it assesses whether students can explain the role of competition, market power and coordination in markets. Students have to prove that they understand and can analyze the impact of firm behavior and industry structure on welfare and evaluate the welfare effects of competition policy. Students will be permitted to use non-programmable calculators during the examination. The exam duration is 90 minutes.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Undergraduate class work in microeconomics or industrial organisation.

Content:
The course provides an overview about firm behaviour. Topics discussed include:
• Competition and market power in markets
• The structure of industries and markets
• Strategic interactions among firms
• Vertical relations and coordination in markets
• The effect of firm behaviour on industry efficiency and societal welfare

Intended Learning Outcomes:
After successfully completing the module, students will be able:
• To describe the various forms of market structure;
• To explain the role of competition, market power and coordination in markets;
• To apply analytical tools to analyse strategic firm behaviour and interactions;

• To understand the impact of firm behaviour and industry structure on welfare and competition policy.
• To explain coordination and the conditions for efficient coordination.

Teaching and Learning Methods:
Application of various teaching methods to optimize structure and rhythm:
• Lecture
• Interactive methods
• Experiments in the lecture
• Discussion of relevant literature
• Exercises

Media:

Reading List:
Recommended textbook
- J. Church and R. Ware, Industrial Organization: A Strategic Approach, first edition, McGraw-Hill, 2000. (available for free online)

Other suggestions:
1. Jean Tirole: Industrial Organization.
2. Belleflamme and Peitz: Industrial Organization: Markets and Strategies.
3. Motta: Competition Policy: Theory and Practice

Responsible for Module:
Menapace, Luisa; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
The Economics of Firm Competition (WI001281, englisch): Vorlesung (Vorlesung, 2 SWS)
Menapace L, Rackl J

The Economics of Firm Competition (WI001281, englisch): Übung (Übung, 2 SWS)
Menapace L, Rackl J
For further information in this module, please click campus.tum.de or here.

EM-WahlKat: Elective Modules Modules Energy Markets | Wahlfächer Energy Markets

WahlKat-EM: Catalogue of Elective Modules: Modules Energy Markets | Wahlkatalog: Energy Markets

Module Description

WI000946: Energy Markets I | Energy Markets I

Version of module description: Gültig ab summerterm 2021

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

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

Description of Examination Method:
The module entails a written exam at the end of the term (60 minutes). In order to optimally assess the students' achievements, the exam will consist of both, a multiple choice part (20%) and open questions (80%). In the multiple choice part students mainly show that they have professional knowledge regarding the characteristics of energy markets and that are able to classify it. With answering the open questions, students demonstrate their ability to solve problems as well as their ability of abstraction. Mathematical problems will be complemented by questions mainly aiming at economic intuition and thought patterns. Apart from a nun-programmable calculator no further tools or documents are permitted (closed book).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in economics (competition theory), basics in corporate strategy (Porter etc.), ideally industrial economics (market power, oligopoly, barriers to market entry, transparency etc.) and trade (call, put, forward, future etc.)

Modules:
- Investment and Financial Management
- Mikroökonomik (Economics I)
- Industrieökonomik (Industrial Economics)

- Introduction to Strategy and Organization

Content:
This module gives a broad overview of energy markets and energy industries across all commodities. It covers the whole energy value chain from primary energy supply to energy consumption and presents the most relevant economic concepts.
Focus issues are forecasting energy demand, primary energy exploration and production, supply and demand curves / merit orders in different commodities, specific feature of energy markets, price formation and organised energy trading.
The module will be continued in summer with energy markets 2, focusing on renewables and grid regulation.

Intended Learning Outcomes:
After successful participation in the module, students possess a broad basic knowledge regarding the economic specifications of energy markets. Furthermore, students are able to solve energy related problems self-reliantly using both, mathematical techniques as well as attained economic intuition.
Participants are moreover able to transfer economic principles on the special demands of energy markets.
After studying the provided literature, students are able to analyze and assess questions arising in terms of energy policy and recent developments in the fields of energy markets.
Participation in the module leads to a better understanding of energy markets and enables students to develop and evaluate business processes and models in the field of energy economics.
Taking part in the module enables students to competently advocate their views in discussions addressing energy economics and markets.

Teaching and Learning Methods:
The module consists of a lecture and an associated exercise course. The lecture provides basic knowledge about economical characteristics of energy markets via presentations. Students are encouraged to study the literature and discuss the provided topics. During the exercise courses, selected examples of problems arising in energy markets are discussed.

Media:
Slides and exercises

Reading List:
Erdmann, G. / Zweifel, P. (2010) Energy Economics: Theory and Applications; Springer 2017.
Ströbele, W. / Pfaffenberger, W. / Heuterkes, M. (2012) Energiewirtschaft - Einführung in Theorie und Politik; 3. Auflage; Oldenbourg 2012.
Bhattacharyya, S. (2011) Energy Economics - Concepts, Issues, Markets and Governance; Springer 2011.

Responsible for Module:
Wozabal, David; Prof. Dr. rer. soc.

Courses (Type of course, Weekly hours per semester), Instructor:
Energy Markets I (WI000946) (Vorlesung, 2 SWS)
Ikonnikova S [L], Bieberbach F, Gatscher D

Energy Markets I - Exercise (WI000946) (Übung, 2 SWS)
Ikonnikova S [L], Gatscher D
For further information in this module, please click campus.tum.de or here.

Module Description

WI000992: Energy Trading | Energy Trading

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
The module examination is based on a written exam (60 minutes). The written exam has two parts. The first part (≤ 20%) consists of multiple-choice questions. Students have to demonstrate that they are familiar with the basic concepts, products and functioning of energy markets and energy trading. They show that they are able to compare key concepts of risk management.
The second part (≥ 80%) consists of open questions and calculations. In the open questions, students have to show their ability to analyze theoretical concepts and current developments.
In the calculations, students have to proof their ability to apply methods and concepts of Energy Trading. Students show that they can analyze real-life tasks in the energy industry, explain the market price developments and design appropriate trading strategies and energy portfolios, and.
Students are allowed to use a non-programmable calculator.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic understanding of energy industry and energy techniques

Content:
In the course of this module, students gain deep insights into the value chain of energy trading. Thereto, the module covers the following topics: development of european and global energy markets; energy markets as fundament for risk management; risk management of company portfolios from the perspective of energy producers, consumers and traders; grid-bound energy sources electricity and gas supplemented by references on coal, crude oil and emission certificates.

Intended Learning Outcomes:
Upon successful completion of the module, students can name the most important energy market places and their products. They understand the functioning of energy markets and the central role of energy trading. Further, they understand key concepts of risk management and can compare them. Moreover, they can select organizational concepts and most important supporting processes of energy trading fitting to a given situation. They can assess the order book (e.g. mid-prices, spreads), evaluate financial products, and calculate clearing prices of interconnected systems and hedging requirements. Finally, they can analyze realistic tasks in the energy industry, transfer them into appropriate trades and trading portfolios, and explain the market price developments.

During the exercise course, students deepen their knowledge on how to program the financial operations of an order book, whether in an auctions setting or in continuous trading. They will learn how to hedge a portfolio while employing financial derivative instrument strategies. They will be able to calculate key financial indicators, such as mark-to-market valuation, build and interpret a price forwards curve, and calculate and interpret key risk measures such as Value-at-Risk and Conditional-Value-at-Risk. Furthermore, they will calculate the marginal cost of electricity generation and its impact on the economics of CO2 emissions trading. Additionally, they will learn how to set up and solve a mathematical optimization problem to decide the best generation mix setup.

Teaching and Learning Methods:
The module combines various learning methods:
- Basic knowledge, theoretical concepts and practical examples will be provided through the lecture
- Controversial discussions and active participation in class are encouraged to deepen understanding of the concepts presented
- In integrated exercises, students will apply their theoretical knowledge to concrete issues and analyze selected case studies
- Students will get insights into practice by an excursion to the trading floor of Stadtwerke München

The exercise course is carried out in a typical exercise resolution manner. Problem sheets are handed out to the students beforehand, they solve them at home before the session, and the sessions are used to solve the problem set.
However, students will be asked to apply the learned content immediately, interactively, through exercises and examples that will allow them to develop a practical understanding of the presented concepts.

Students are expected to come to the exercise courses to better prepare for the examThe exercises are meant to help the students master their understanding of concepts and methods seen in the lecture, and develop their ability to apply them to real world problems, and to implement solutions using a spreadsheet tool.
Students perform these activities in groups of two, to stimulate discussion and reflection, and engage in a positive and informal learning environment.

Media:
Presentation slides, white board, spreadsheet exercises

Reading List:
• Bhattacharyya, S.: Energy Economics – Concepts, Issues, Markets and Governance. Springer 2011.
• Borchert, J.; Schemm, R.; Korth S.: Stromhandel – Institutionen, Marktmodelle, Pricing und Risikomanagement. Schäffer Poeschel 2006.
• Burger, M.; Graeber, B.; Schindlmayr, G.: Managing Energy Risk. Wiley Finance 2008.
• Erdmann, G.; Zweifel, P.: Energieökonomik – Theorie und Anwendungen. Springer, 2nd Edition 2010.
• Fiorenzani, S.; Ravelli, S; Edoli, E.: The Handbook of Energy Trading. John Wiley & Sons 2012.
• Hull, J.C.: Options, Futures and Other Derivatives. Prentice Hall, 8th Edition, 2011.
• James, T.: Energy Markets – Price Risk Management and Trading. Wiley Finance 2008.
• Konstantin, P.: Praxisbuch Energiewirtschaft. Energieumwandlung, -transport und -beschaffung im liberalisierten Markt. Springer, 2nd Edition, 2009.

Responsible for Module:
Ikonnikova, Svetlana; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Energy Trading (WI000992, englisch): Exercise (Übung, 2 SWS)
Gatscher D

Energy Trading (WI000992, englisch) (Vorlesung, 2 SWS)
Illerhaus S (Gatscher D)
For further information in this module, please click campus.tum.de or here.

Module Description

WI001145: Energy Economics | Energy Economics

Version of module description: Gültig ab summerterm 2021

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

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

Description of Examination Method:
The module entails a final written exam (120 minutes). The exam is a closed-book exam. By answering the questions students show their ability to differentiate and evaluate different market structures (at wholesale, transportation and retail level) in energy markets, e.g. in gas, coal, oil and power markets. Moreover students show their ability to discuss and apply theoretical and empirical methods to selected topics in energy markets. They show that they are able to analyze and assess recent energy market developments, such as for instance the energy transition, using the theoretical and empirical tools they have acquired.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Courses at TUM or elsewhere in microeconomics and introductory statistics or econometrics

Content:
This module covers the following topics:
Economics of energy markets
Analysis of producer strategies
Analysis of consumer behavior
Fundamentals of primary energy markets
Fundamentals of electricity markets
Analysis of network industries
Network regulation
Microeconomics
Game theory
Econometrics
Energy policy

Intended Learning Outcomes:
Students are able to explain and to differentiate different market structures (at wholesale, transportation and retail level) in energy markets, e.g. in gas, coal, oil and power markets. Furthermore, they are able to summarize and compare different strategies and behavior of producers and consumers, as well as on different forms of regulation of network industries. Students are also able to discuss and apply theoretical and empirical methods to selected topics in energy markets. With these tools student will thus be able to analyze and assess recent energy market developments, such as for instance the energy transition.

Teaching and Learning Methods:
The module is a lecture consisting of PowerPoint presentations so as to offer and explain to students all different topics covered in this module. A guest lecture is planned in which practitioners present on selected topics in energy markets. The exercise course comprises different problem sets that discuss problems covered during the lecture. Problem sets are solved individually or in group work and, supported by a presentation, derived and solved jointly with the tutor.

Media:
PowerPoint, exercise sheets, whiteboard, reader

Reading List:
Viscusi, W. et al. (2005): Economics of Regulation and Antitrust, MIT Press. Stoft, S. (2002): Power System Economics, Wiley. Selected journal articles.

Responsible for Module:
Schwenen, Sebastian; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Energy Economics (WI001145) (Vorlesung, 2 SWS)
Schwenen S, Kiszka A

Energy Economics - Exercise (WI001145) (Übung, 2 SWS)
Schwenen S, Kiszka A
For further information in this module, please click campus.tum.de or here.

Specialization in Management: Life Sciences Management and Policy | Management-Schwerpunkt: Life Sciences Management and Policy

AdvSem-LSMP: Advanced Seminar Life Sciences Management & Policy | Advanced Seminar Life Sciences Management & Policy

Module Description

MGT001344: Advanced Seminar Life Sciences, Management & Policy: Food Governance, Fairness and Sustainability Literature Review and Presentation Skills | Advanced Seminar Life Sciences, Management & Policy: Food Governance, Fairness and Sustainability Literature Review and Presentation Skills

Version of module description: Gültig ab winterterm 2022/23

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:
Grading will be based on a written report (consisting of a literature review) and an oral presentation (20 min) with subsequent discussion, both with an individual and a teamwork component. Both the literature review and the oral presentation are worth 50% of the grade. The literature review and the oral presentation will verify that students can conduct in-depth research and present their results to a wider audience. They will also confirm that they are prepared for their Master Thesis.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge in microeconomics

Content:
The module deals with issues of governance, fairness and sustainability in the food system.
Key topics of the module may thereby include:
-Locks-ins and levers for facilitating a transitions toward more sustainable food systems;
-Food labels (origin-based labels, animal welfare labels);

-Food quality standards;
-Potential paths for a transition to more sustainable food systems
-Private and public governance in food sectors
-Fairness in business relationships
-European and national regulations and policies concerning the food sector
From a methodological point of view, the focus of this module is on
-Exploratory and Qualitative research methods
-Scientific writing skills

Intended Learning Outcomes:
After successful completion of this module, students will have in-depth knowledge on how to analyze the scientific literature and present a scientific paper on the governance, fairness and sustainability in agro-food systems. Moreover, students will be able i) procure and screen relevant literature, ii) conduct a systematic review of the scientific literature; iii) present scientific findings in front of their peers and v) entering and moderating a scientific discussion on their topic. The module thereby prepares students for the scientific work to be conducted in their master theses.

Teaching and Learning Methods:
The module is a seminar and provides students with in-depth knowledge of governance, fairness and sustainability grounded in economic theory. The seminar includes a set of lectures on selected topics concerning the governance, fairness and sustainability of food system.
Guided by the instructor(s) through the entire process, students will work alone and/or in groups around a topic in governance, fairness and/or sustainability.
Activities are carried out in parallel and in coordination with one or more foreign universities and students will have the opportunity to collaborate and exchange with students from those universities. The course hence takes place online.
Together with “Advanced Seminar Economics & Policy/Life Sciences & Management – Food system governance, fairness and sustainability, Scientific Writing and Exploratory Research Methods”, this module offers a comprehensive toolkit to prepare students for their master thesis as well as for a career in science.

Media:
PowerPoint presentations, economic textbooks, scientific articles

Reading List:
Barrett, Christopher B. (2021): Overcoming Global Food Security Challenges through Science and Solidarity. In American Journal of Agricultural Economics 103 (2), pp. 422–447. DOI: 10.1111/ajae.12160.
Béné, Christophe; Fanzo, Jessica; Prager, Steven D.; Achicanoy, Harold A.; Mapes, Brendan R.; Alvarez Toro, Patricia; Bonilla Cedrez, Camila (2020): Global drivers of food system (un)sustainability: A multi-country correlation analysis. In PloS one 15 (4), e0231071. DOI: 10.1371/journal.pone.0231071.
Bowie, N. E. (1988). Fair markets. Journal of Business Ethics, 7(1-2), 89-98.

Christopher B. Barrett, Thomas Reardon, Johan Swinnen and David Zilberman (2020): Agri-food Value Chain Revolutions in Low-and Middle-Income Countries. In Journal of Economic Literature,
Clapp, Jennifer (2018): Mega-Mergers on the Menu: Corporate Concentration and the Politics of Sustainability in the Global Food System. In Global Environmental Politics 18 (2), pp. 12–33. DOI: 10.1162/glep_a_00454.
Giuliano Martiniello and Ricardo Azambuja: Contracting Sugarcane Farming in Global Agricultural Value Chains in Eastern Africa: Debates, Dynamics, and Struggles.
Glavee-Geo, Richard; Engelseth, Per; Buvik, Arnt (2021): Power Imbalance and the Dark Side of the Captive Agri-food Supplier-Buyer Relationship. In Journal of business ethics : JBE, pp. 1–20. DOI: 10.1007/s10551-021-04791-7.
Gudbrandsdottir, Ingunn Y.; Olafsdottir, Gudrun; Oddsson, Gudmundur Valur; Stefansson, Hlynur; Bogason, Sigurdur G. (2021): Operationalization of Interorganizational Fairness in Food Systems: From a Social Construct to Quantitative Indicators. In Agriculture 11 (1), p. 36. DOI: 10.3390/agriculture11010036.
Hamann, Steffi (2020): The global food system, agro-industrialization and governance: alternative conceptions for sub-Saharan Africa. In Globalizations 17 (8), pp. 1405–1420. DOI: 10.1080/14747731.2020.1730050.
Koen Deconinck (2019): New evidence on concentration in seed markets. In Global Food Security 23, pp. 135–138.
Singh, Sukhpal (2019): The Export Value Chain of Baby Corn in India: Governance, Inclusion and Upgrading. In Agrarian South: Journal of Political Economy 8 ((1–2)), pp. 172–207.
Thompson, Merisa S.; Cochrane, Alasdair; Hopma, Justa (2020): Democratising food: The case for a deliberative approach. In Rev. Int. Stud. 46 (4), pp. 435–455. DOI: 10.1017/S0260210520000017.
Wood, Benjamin; Williams, Owain; Nagarajan, Vijaya; Sacks, Gary (2021): Market strategies used by processed food manufacturers to increase and consolidate their power: a systematic review and document analysis. In Globalization and health 17 (1), p. 17. DOI: 10.1186/s12992-021-00667-7.
Hansman, Christopher; Hjort, Jonas; León, Gianmarco; Teachout, Matthieu (2017): Vertical Integration, Supplier Behavior, and Quality Upgrading among Exporters. Cambridge, MA.
Burchardi, Konrad B.; Gulesci, Selim; Lerva, Benedetta; Sulaiman, Munshi (2019): Moral Hazard: Experimental Evidence from Tenancy Contracts*. In The Quarterly Journal of Economics 134 (1), pp. 281–347. DOI: 10.1093/qje/qjy023.

Responsible for Module:
Menapace, Luisa; Prof. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar Economics, Policy & Econometrics /Life Sciences, Management & Policy (MGT001344, englisch): Food Governance, Fairness and Sustainability Literature Review and Presentation Skills (Seminar, 4 SWS)
Ola O
For further information in this module, please click campus.tum.de or here.

Module Description

WIB14002: Advanced Seminar Life Sciences, Management & Policy: Sustainable Entrepreneurship - Theoretical Foundations | Advanced Seminar Life Sciences, Management & Policy: Sustainable Entrepreneurship - Theoretical Foundations

Version of module description: Gültig ab summerterm 2017

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 research paper (max. 7.500 words). The students show that they are able to apply theoretical perspectives to the context of life sciences. Moreover, they develop an argument matching the concept of sustainable entrepreneurship as a promising approach for addressing complex sustainability issues in general and in the field of life sciences in particular. In the research paper students show that they can evaluate different approaches and develop their own ideas for life sciecne-related sustainable ventures.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Courses in entrepreneurship, corporate sustainability and/or sustainability marketing are recommended.

Content:
Whether it is tackling climate change, resource degradation or social inequalities - responding to sustainability issues constitutes the biggest challenge for businesses in the 21st century. Embracing a great range of industries including food, energy or textiles, the field of life sciences is a key area for sustainability. Since the production of these goods accounts for an extensive use of resources, there is great potential for effecting real improvements on a way towards more sustainable production and lifestyles. The course "Advanced Seminar Life Sciences and Management" will investigate this exciting and ongoing industrial transformation. It will deal with the following topics (all topics will be explained in general and then discussed in the context of life sciences in particular):

1) Introduction to Sustainability and Entrepreneurship
2) Sustainable Entrepreneurship
3) Opportunity Identification
4) Development of Double and Triple Bottom Line Solutions
5) Forming and Funding of New Sustainable Ventures
6) Market Entry
7) Sustainable Entrepreneurship and Life Sciences - Reflections and Discussion

Intended Learning Outcomes:
Upon successful completion of this module, students will be able to (1) summarize and (2) evaluate the socio-economic problems society is facing. They will (2) match the concept of sustainable entrepreneurship as a promising approach for addressing complex sustainability issues in general, and in the field of life sciences in particular. More specifically, students will (3) be able to identify the venture creation process from opportunity identification to market entry in the context of sustainability and life sciences. In addition, participants will be able to (4) apply this knowlede to the field of life sciences. Finally, the students will be able to (5) critically evaluate case studies from the field of life sciences and to (6) create own ideas for sustainable ventures in this context.

Teaching and Learning Methods:
The module is a seminar which intends to familiarize the student with the relevant literature and follows an interactive course format with group work assignments and guest lectures. This is the appropriate format for this advanced level module because it encourages the students to go into further detail and to deal with the issues in an integral, interactive and independent way.

Media:
Presentations, slides, cases, links and further literature will be provided via www.moodle.tum.de

Reading List:
Muñoz, P., & Cohen, B. (2018). Sustainable entrepreneurship research: taking stock and looking ahead. Business Strategy and the Environment.

The module is based on key scientific papers on each topic. These form the basis for classroom discussions and are to be used for developing an argument in the reflection essay. All articles are provided as pdf files in TUM Moodle (https://www.moodle.tum.de).

Responsible for Module:
Belz, Frank-Martin; Prof. Dr. oec.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar Life Sciences, Management & Policy / Innovation & Entrepreneurship (WIB14002): Sustainable Entrepreneurship - Theoretical Foundations (Limited places) (Seminar, 4 SWS)

Belz F, Salvi E

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

LSMP-WahlKat: Elective Modules Modules Life Sciences Management & Policy | Wahlfächer Life Sciences Management & Policy

WahlKat-LSMP: Catalogue of Elective Modules: Life Sciences Management & Policy | Wahlkatalog: Life Sciences Management & Policy

Module Description

WZ0041: Economics of Technology and Innovation | Economics of Technology and Innovation

Version of module description: Gültig ab summerterm 2021

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:
There will be a written exam (Klausur) of 120 minutes at the end of the semester. The students will be asked to demonstrate their ability to understand and analyze concepts and methodological approaches of the economics of technology and innovation using conceptual frameworks and methods currently used in the field. A written exam is necessary in order to assess the holistic understanding and analytical competencies of the students.

The students are requested to demonstrate that they understand the implications of innovation adoption (e.g. the potential effect of an innovation for non-adopters), can distinguish between the effects of various constraints and incentives on adoption (e.g. profitability and access to credit), and are aware of commonly known methodological pitfalls (e.g. omitted variable bias, reverse causality). In addition, the student will have the ability to create their own research designs on specific case studies provided by the instructors.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basics of microeconomics, statistics, econometrics

Content:
This course covers the determinants of technology adoption and innovations and their effects on economic, environmental, and social outcomes.

The course consists of lectures and seminar activities. The lectures are devided in six blocks:
1) Role and Relevance of Innovation and Technology
2) Theoretical Models on the Economics of Innovation and Technology
3) Empirical Models on the Economics of Agricultural Innovation and Technology
a) Matching and classification
b) Regression Discontinuity Design
c) Instrumental Variables
d) Difference-in-Differences
e) Synthetic Control
4) Seminal Articles
5) Recent Trends
6) Open Questions and Presentations
In the seminar the students present specific technological and economic articles followed by discussions.

Intended Learning Outcomes:
After successful completion of the course, the students will be able to:
(1) apprehend the basic concepts of technology and its role on the economic development,
(2) understand the socio-economic effects and relevance of agricultural innovations,
(3) explore the reasons why innovations usually do not instantly and fully diffuse,
(4) select and apply the appropriate economic methods used to understand points (1) and (2),
(5) critique journal articles pertaining to economics of technology innovation and adoption, especially regarding research methodology and topics (e.g. experiments investigating behavioral biases, estimation of profit heterogeneity).
(6) examine whether a research design is able to identify the effects and / or adoption determinants of an agricultural technology
(7) provide hands-on practice to implement these research designs
(8) identify what kind of research would make a significant contribution to the field of innovation economics..

Teaching and Learning Methods:
Half the course (2SWS) consists of lectures, the other half (2SWS) consists of student presentations and discussions. In the Lecture part of the course, theoretical concepts and practice exercises will be given by the lecturers on the blackboard and by PowerPoint presentations to build the required knowledge base in innovation and technology economics. In addition, under the supervision and help of the lecturer, in-class application exercises will be used to create real-world problems for which students in randomly assigned groups will create and solve problems. Discussion of relevant scholarly articles and literature will be used to aid understanding of the topic covered. The lectures will promote the basics and the seminar will build upon this. This encourages the students to independently and self-reliantly study the literature guided by a

structured framework. In the Seminar part of the course, Students will give an in-class presentation (~15 min) of a paper related to innovation and technology economics that they will choose from a list of references provided by the instructor.

Media:
Presentation slides, Blackboard, hand-outs, Moodle course to provide materials (pdf of papers to read)

Reading List:
Angrist, J.D. and J.-S. Pischke Mastering'metrics: The path from cause to effect, Princeton University Press, 2014). Carter, M.R. "What farmers want: The “gustibus multiplier” and other behavioral insights on agricultural development." Agricultural Economics, Vol. 47, (2016) pp. 85-96.
Conley, T.G. and C.R. Udry "Learning about a new technology: Pineapple in ghana." The American Economic Review, (2010) pp. 35-69.
Duflo, E., M. Kremer and J. Robinson "Nudging farmers to use fertilizer: Theory and experimental evidence from kenya." The American Economic Review, Vol. 101, (2011) pp. 2350-2390.
Feder, G., R.E. Just and D. Zilberman "Adoption of agricultural innovations in developing countries: A survey." Economic development and cultural change, (1985) pp. 255-298.
Foster, A.D. and M.R. Rosenzweig "Microeconomics of technology adoption." Annual Review of Economics, Vol. 2, (2010).
Griliches, Z. "Hybrid corn: An exploration in the economics of technological change." Econometrica, Journal of the Econometric Society, (1957) pp. 501-522.
Karlan, D., R. Osei, I. Osei-Akoto and C. Udry "Agricultural decisions after relaxing credit and risk constraints*." Quarterly journal of economics, Vol. 129, (2014).
Sauer, J. and D. Zilberman "Sequential technology implementation, network externalities, and risk: The case of automatic milking systems." Agricultural Economics, Vol. 43, (2012) pp. 233-252.
Self, S. and R. Grabowski "Economic development and the role of agricultural technology." Agricultural Economics, Vol. 36, (2007) pp. 395-404.
Sunding, D. and D. Zilberman "The agricultural innovation process: Research and technology adoption in a changing agricultural sector." Handbook of agricultural economics, Vol. 1, (2001) pp. 207-261.
Suri, T. "Selection and comparative advantage in technology adoption." Econometrica, Vol. 79, (2011) pp. 159-209.
Vrachioli, M., Stefanou, S.E. and Tzouvelekas, V. “Impact Evaluation of Alternative Irrigation Technology in Crete: Correcting for Selectivity Bias.” Environ Resource Econ, Vol. 79, (2021) pp. 551–574. https://doi.org/10.1007/s10640-021-00572-y
Wuepper, D. and T. Lybbert "Perceived self-efficacy, poverty, and economic development." Annual Review of Resource Economics, Vol. 9, (2017).
Wuepper, D., J. Sauer and L. Kleemann "Sustainable intensification amongst ghana’s pineapple farmers: The complexity of an innovation determines the effectiveness of its training", Environment and Development Economics: Online First, 2017).

The list will be expanded and updated using material from a variety of textbooks and journal papers corresponding to each of the topics.

Responsible for Module:
Sauer, Johannes; Prof. 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

WZ0043: Risk Theory and Modeling | Risk Theory and Modeling

Version of module description: Gültig ab winterterm 2017/18

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

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

Description of Examination Method:
In a written examination (120 minutes, Klausur), students demonstrate their theoretical knowledge of risk and the intuition behind various concepts. In written answers regarding the measurement of risk and the decision-making under risk, they prove their understanding of these concepts in both theory and practice. The ability to apply mathematical tools is proven by the solution of specific calculus problems. Further, students discuss assumptions under which a proposed research approach is appropriate and whether there might be better ways to investigate a specific research problem.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students taking this course should be familiar with the basics of microeconomics as well as probability measurement. However, all necessary concepts will be introduced before application.

Content:
- Definitions and sources of risk
- Risk attitude and the utility function
- Random variables and statistical measures of risk evaluation
- Value-at-risk
- Portfolio optimization
- Production decisions under risk
- Price analysis
- Real options

Intended Learning Outcomes:
Upon completion of the module, students are able to

- understand the various sources of risk in a broad range of sectors and industries,
- understand how economic decisions are made in the presence of risk,
- apply mathematical tools to evaluate risk with respect to products, processes and structure related decisions
- and understand how decision-making under risk is analyzed in the scientific literature

Teaching and Learning Methods:
The module consists of 2 SWS lectures and 2 SWS exercises. During lectures, concepts and tools will be presented to the students in slide shows. An interactive lecture atmosphere is intended to ensure that students' questions are answered right away. Further, exercises accompany the lecture contents. These exercises are meant to illustrate lecture contents and provide students with hands-on experience with the presented concepts to make them more graspable.
Toward the end of the course, when students are acquainted with the most important concepts, selected publications (both seminal papers and most recent ones) in risk research are presented and discussed. This provides students with an insight into how the lecture contents are applied in the scientific literature.

Media:
Presentation slides, Microsoft Excel files, hand-outs

Reading List:
Chavas, J. P.: Risk Analysis in Theory and Practice". Elsevier, San Francisco 2004.
Quiggin, J., Chambers R. G: Uncertainty, Production, Choice, and Agency: The State-Contingent Approach. Cambridge 2000.

Responsible for Module:
Sauer, Johannes; Prof. Dr. agr.

Courses (Type of course, Weekly hours per semester), Instructor:
Risk Theory and Modeling - Lecture (WZ0043) (Vorlesung, 2 SWS)
Sauer J [L], Frick F, Vo H

Risk Theory and Modeling - Exercises (WZ0043) (Übung, 2 SWS)
Sauer J [L], Frick F, Vo H
For further information in this module, please click campus.tum.de or here.

Module Description

WZ1590: Climate Change Economics | Climate Change Economics

Version of module description: Gültig ab winterterm 2014/15

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:
There will be a written exam (Klausur) of 90 minutes at the end of the semester. The students will be asked to demonstrate, within the stipulated amount of time using predefined methods and resources, their ability to outline the challenges climate change poses to regulators, propose pragmatic solutions and strategies as well as ways of implementing them. This would be based on the competences acquired from the relevant literature of economic modeling, theories of climate change and their understanding from the course content. The written exam is an appropriate assessment method to evaluate the degree to which the students understand the theoretical framework of climate change implications as well as provides an opportunity for them to put forward arguments based on existing theory.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge:
• Micro Economics (Welfare Economics)
• Environmental Economics
• Resource Economics

Content:
This course covers the trends in current and future climate change and their effects on economic and social outcomes.

The lectures are divided into ten sessions:
1. Introduction to the Basic Science of Climate Change
- The students will learn about the scientific themes of global climate change and the economic dimension of the phenomenon.

2. Basic Economics
- The students will learn how a market economy can be efficient and socially optimal as well as about the prospects of externality.
3. Optimal Emission Levels
- The students will learn of the optimal abatement path and its uncertainty with respect to damages as well as Integrated Assessment Models (IAMs).
4. Intra-generational equity in climate policy
- The students will learn about how to account for equity across space (intergenerational equity) when deriving optimal emission levels.
5. International Environmental Agreements
- The students will learn about the dynamics behind common strategies towards achieving some form of optimal emission level.
6. Policy Instruments
- The students will learn about diverse instruments such as quality-based approach and Pigouvian Tax.
7. Regulation via Prices vs. Quantities
- The students will learn what circumstances will a regulator prefer prices over quantities and vice versa.
8. Credit-based Mechanisms
- The students will learn about how to deal with countries that do not want to commit, but have a high potential for low-cost reductions.
9. German Climate Policy
- The students will learn about German Climate Action - strategies and policies
10. European Union Emission Trading Scheme - EU ETS

Intended Learning Outcomes:
After successfully completing the module, students are able to:
• Evaluate and formulate economic models related to climate change.
• Apply theoretical model to climate change regulations as well as policies that affect emission levels.
• Analyze the complexity, uncertainty and possibilities associated with optimal emission level.
• Apply appropriate instruments for optimal emission level that are efficient and cost-effective.
• Understand climate negotiations (club) and climate action strategies are currently being implemented.

Teaching and Learning Methods:
The course mainly consists of lectures (4 SWS). The lecture will provide a foundation upon which to build the ensuing discussions on climate change issues from an economic perspective. The content of the module is expected to be transferred to the students in an interactive learning manner were, among others, emission reduction instruments are scrutinized. This encourages the students to independently and self-reliantly study the literature guided by a structured framework.

Media:
PowerPoint, flipchart, internet portals, online reports etc.

Reading List:
Bréchet, T., & Eyckmans, J. (2009). Coalition theory and integrated assessment Modelling: Lessons for climate governance. Global Environmental Commons: Analytical and Political Challenges in Building Governance Mechanisms.
Rohling, M., & Ohndorf, M. (2012). Prices vs. quantities with fiscal cushioning. Resource and Energy Economics, 34(2), 169-187.
MacKenzie, I. A., & Ohndorf, M. (2012). Optimal monitoring of credit-based emissions trading under asymmetric information. Journal of regulatory economics, 42(2), 180-203.
Hake, J. F., Fischer, W., Venghaus, S., & Weckenbrock, C. (2015). The German Energiewende–history and status quo. Energy, 92, 532-546.
Climate Action Plan 2050 Principles and goals of the German government's climate policy. https://www.bmu.de/fileadmin/Daten_BMU/Pools/Broschueren/klimaschutzplan_2050_en_bf.pdf
EU ETS Handbook. https://ec.europa.eu/clima/sites/clima/files/docs/ets_handbook_en.pdf

Responsible for Module:
Sauer, Johannes; Prof. Dr. agr.

Courses (Type of course, Weekly hours per semester), Instructor:
Climate Change Economics (WZ1590, englisch) (Vorlesung, 4 SWS)
Sauer J [L], Canessa C, Frick F
For further information in this module, please click campus.tum.de or here.

AdvSem-MM: Advanced Seminar Management & Marketing | Advanced Seminar Management & Marketing

Module Description

WI001278: Advanced Seminar Marketing, Strategy & Leadership: Success and failure of co-founding teams | Advanced Seminar Marketing, Strategy & Leadership: Success and failure of co-founding teams

Insights from science and practice

Version of module description: Gültig ab winterterm 2023/24

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 360	**Self-study Hours:** 270	**Contact Hours:** 90

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

Description of Examination Method:
The exams consist of a) summarizing and presenting current knowledge on topics of team processes and dynamics b) writing a seminar paper on a given topic in the field of co-founding team success and failure and c) written presentation of scientific knowledge for practitioners. The results of the work should show that the students
- have acquired current and relevant academic and practical literature on the topic of team processes in founding teams and are able to present them clearly and precisely
- have dealt intensively with the topic of group dynamics and entrepreneurship
- are able to process scientific content
- have presentation and communication skills that enable them to present their findings on challenging topics, in a clear and structured manner, and to demonstrate the applicability of their findings to practice.

The final grade is an average of an individual coursework (40% summary and presentation of scientific studies, 30% seminar paper on a scientific question), and a team assignment (30%, elaboration of the topic for practice).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fluent in English

Interest in the topics of team success, team dynamics, and entrepreneurship from both an academic and practical perspective

Content:
The seminar "Success and failure of co-founding teams " is an interactive learning experience that introduces students to the relevance of a successful team for the success of startups. The different facets of teamwork will be explored from a scientific and practical perspective. In the seminar, measures will be developed to make startup teams successful.

In the course of the seminar, the students will deal with one interpersonal factor each, which can influence the success of teams. The students will independently work out the current state of the art on their topic and present it to their fellow students. Together, under the guidance of the lecturers, measures are derived that increase the success of founding teams. In addition, the students learn the basics of scientific work. Students are supported through lectures by professors and invited experts, as well as through interactions with teaching assistants, in both methodological and entrepreneurial topics.

Intended Learning Outcomes:
Theory:
Students will learn the most important theories and current trends about team processes in the context of startup founders. Topics that will be covered are for example the ideal team size, influences of on creativity, diversity, personality, communication patterns, emotions or negotiation skills.
In addition, students learn the key thoughts and content of renowned entrepreneurs, VCs and movers in the entrepreneurial ecosystem.
They will learn the fundamental concepts and application areas of communication and interaction research in the context of startups, and learn to understand and present current research in these areas.

Practice:
Students will gain deep insights into the key interpersonal influences of startup success. They will be enabled to summarize the most important factors influencing interaction on team success in startups and present them for practice. In addition, interactive exercises will complement the theoretical knowledge in the form of practical experience.

Methodology:
Students will learn from both academics and practitioners about the theory and practice of startup success based on team processes. We work with academic journals, guest lecturers as well as excerpts from recent videos, podcasts, conference submissions from movers and shakers in the startup scene.

Teaching and Learning Methods:
Der Kurs besteht aus Vorträgen und von den Studierenden durchgeführten Präsentationen. Die Vorträge werden von Universitäts- und Gastdozierenden gehalten, die führende Expert:innen in den Bereichen Entrepreneurship und Interaktion sind.

Media:
Power-Point, Videos, Miro-Board, Moodle, guest speaker, team work.

Reading List:
Breugst, N., & Preller, R. (2020). Where the magic happens: Opening the black box of entrepreneurial team functioning. In The Psychology of Entrepreneurship (pp. 80-96). Routledge.
de Mol, E. (2019). What makes a successful startup team. Harvard Business Review, 21.
Knight, A. P., Greer, L. L., & De Jong, B. (2020). Start-up teams: A multidimensional conceptualization, integrative review of past research, and future research agenda. Academy of Management Annals, 14(1), 231-266.
Patzelt, H., Preller, R., & Breugst, N. (2021). Understanding the life cycles of entrepreneurial teams and their ventures: An agenda for future research. Entrepreneurship Theory and Practice, 45(5), 1119-1153.
Ivanova, S., Treffers, T., Langerak, F., & Groth, M. (2022). Holding Back or Letting Go? The Effect of Emotion Suppression on Relationship Viability in New Venture Teams. Entrepreneurship Theory and Practice, 10422587221093295.

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

Courses (Type of course, Weekly hours per semester), Instructor:
What's cooking? Founding start-ups and unicorns in real time (WI001278) (Seminar, 8 SWS)
Welpe I, Born N, Ettner J, Fiedler M, Joas R, Mehrwald P, Treffers T
For further information in this module, please click campus.tum.de or here.

WahlKat-FA: Catalogue of Elective Modules: Finance and Accounting | Wahlkatalog: Finance & Accounting

Module Description

WIB23006: Advanced Seminar Finance & Accounting: Strategy Planning and Steering | Advanced Seminar Finance & Accounting: Strategy Planning and Steering

Strategy Planning & Steering

Version of module description: Gültig ab winterterm 2016/17

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

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

Description of Examination Method:
Grading is based on a seminar paper (max. 16 pages, 40%) and the presentations (10 minutes + 15 minutes discussion, 60%) of the elaborated case studies. The seminar paper should reveal the student's acquired knowledge about the respective seminar topic. Furthermore, the students should critically analyze the key aspects regarding their seminar topic. By presenting their findings in front of the class, students proof that they are able to present the key aspects in a concise manner and that they are able to answer further questions on their presented findings. The paper and the presentations will be processed in teams of 3-4 students, whereas the individual part of each student has to be clearly identifiable.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Working knowledge of the mandatory basic business courses

Content:
The module offers participants insights into the interaction of strategy, planning and steering processes and gives them the opportunity to examine one topic in more detail. Emphasis is put on the transfer and the adaptation of different models and philosophies onto specific industries and companies. The module may serve as a starting point for further research, but also prepares

participants for issues they are likely to face in their professional lives. Goal of the module is to develop a strategy plan and a business model for a company as well as a steering tool.

Intended Learning Outcomes:
After completing this module, students will have an advanced knowledge of the module's core topic. In particular, they will be able to write a seminar paper in an academic way, compile a literature review, and structure their work. Furthermore, students will be able to present their results, answer related questions, and to lead a discussion.

Teaching and Learning Methods:
This module is a seminar.
- working with Case studies
- working with academic papers

Media:
Books, case descriptions, academic papers, presentation slides

Reading List:
• Müller-Stewens, G., Lechner, C.(2005): Strategisches Management. Wie strategische Initiativen zu Wandel führen, 3. Auflage, Stuttgart: Schäffer-Poeschel Verlag
• Ku#nzel, H. (2016). Erfolgsfaktor Performance Management: Leistungsbereitschaft einer aufgekla#rten Generation. Berlin: Springer Gabler

Responsible for Module:
Mohnen, Alwine; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar Finance & Accounting (WIB23006): Strategy Planning & Steering (Seminar, 4 SWS)
Mohnen A, Stäglich J (Mitterer N)
For further information in this module, please click campus.tum.de or here.

Specialization in Technology | Technik-Schwerpunkt

Specialization in Technology: Mechanical Engineering (minor) | Technik-Schwerpunkt: Maschinenwesen Basismodule (minor)

Module Description

MW1907: Introduction to Flight Mechanics and Control | Introduction to Flight Mechanics and Control

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
The examination will be a written exam of 90 minutes duration. The exam includes short questions and calculation questions. Within the short questions the students shall demonstrate the understanding about the important relations and nomenclature within aircraft performance analysis and flight control. The calculation tasks measure the students capability to e.g. perform aircraft performance calculations and to design a simple flight controller. The exam is a closed book exam. Only a non-programmable calculator is allowed.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
The module “Introduction to Flight Mechanics and Control” shall give an overview over the subjects, which are provided by the institute of Flight System Dynamics. The following headwords shall describe the main content of the lecture:
Coordinate systems used in aerospace engineering and transformation between them, ISA standard atmosphere, Forces and moments at the aircraft, Equations of motion considering the aircraft as point mass, Flight Phases, Equation of motion considering the aircraft as rigid body,

Static Stability, Eigen-motion of the aircraft and dynamic stability, Overview Flight Controllers, Autopilots.
These headwords cover a wide range of the subjects, which are content of the lectures “Aircraft Performance”, “Flight Dynamics, Stability and Control” and “Fundamentals of Flight Control”. Since those lectures explain the issues on a high level of detail, the intention of the present lecture is giving an overview. Therefore, simplifying assumptions, such as “ no wind”, “flat non-rotating earth” or “thrust exactly in direction of speed” are introduced to reduce the complexity.

Intended Learning Outcomes:
After the module the student is capable to understand the important relations in aircraft performance assessment and flight control. The student can apply common calculations for aircraft performance analysis in early aircraft design and design basic flight controllers to stabilize and augment aircraft behavior.

Teaching and Learning Methods:
The lecture explains the theoretical background with a presentation. The students shall develop an understanding of the topics of aircraft performance and flight control. The presentation slides will be available as a script for the students. Within the tutorial example calculations shall apply the theory from the lecture and deepen the understanding of the students. The tutorial material will also be made available to the students.

Media:
Lecture Script; Tutorial Taks and Solution Presentations; Matlab Live Scripts

Reading List:
Roskam, J.: Airplane Flight Dynamics and Automatic Flight Control, Part I and II, DARCorporation, Lewrence, KS, 1998, www.darcorp.com; Sevens, B.L. & Lewis F.L.: Aircraft Control and Simulation, John Wiley & Sons, New York, NY, 1995; Schmidt L.V.: Intorduction to Aircraft Dynamics, American Institute of Aeronautics and Astronautics, Reston, VA, 1998, www.aiaa.org; Abzug, M.J.: Computational Flight Dynamics, Americal Institute of Aeronautics and Astronautics, Reston, VA, 1998, www.aiaa.org; Hafer, X. & Sachs, G.: Flugmechanik - Moderne Entwurfs- und Steuerungskonzepte, 3. Auflage, Springer, Berlin, 1993; Russel, J.B.:Performance and Stability of Aircraft, John Wiley & Sons, Baffins Lane, 1998

Responsible for Module:
Holzapfel, Florian; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Introduction to Flight Mechanics and Control - Exercise (Übung, 1 SWS)
Holzapfel F [L], Braun D

Introduction to Flight Mechanics and Control (Vorlesung, 2 SWS)
Holzapfel F [L], Holzapfel F (Braun D)
For further information in this module, please click campus.tum.de or here.

Module Description

MW1920: Machine Dynamics | Maschinendynamik

Version of module description: Gültig ab summerterm 2014

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

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

Description of Examination Method:
Schriftliche Prüfung nach Abschluß der Vorlesung und Übung. In der Prüfung müssen in einem ersten Teil Verständnisfragen beantwortet und in einem zweiten Teil Aufgaben mittels Rechnung analytisch gelöst werden.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse zur Kinematik und Kinetik am gegebenen Berechnungsmodell mit wenigen Freiheitsgraden werden aus der Mechanikausbildung im Bachelorstudium oder im Vordiplom vorausgesetzt.

Content:
Der Student lernt Minimalmodelle und Differentialgleichungen für typische Phänomene der Maschinendynamik kennen. Der Übergang vom realen Objekt zum Modell wird besprochen. Folgende Inhalte sind Schwerpunkte der Vorlesung:
- Modellbildung und Parameteridentifikation (Einführung in die Theorie der Mehrkörpersysteme)
- Starrkörper-Mechanismen (Massen- und Leistungsausgleich, Eigenbewegung)
- Maschinenaufstellung (Fundamentierung, Schwingungsisolation)
- Rotorsysteme (Auswuchten, Kreiselwirkung, Instabilität durch innere Dämpfung)
- Schwingungsfähige Mechanismen (Elastizität am Ab- oder Antrieb)
- Modale Betrachtung von Schwingungssystemen
- Tilger (getunter Zusatzschwinger)
- Dämpfung (Ansätze, Parameter, Eigenwerte und -vektoren)

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung ist der Studierende in der Lage typische Phänomene der Maschinendynamik zu unterscheiden und bei konkreten Problemstellungen an einem realen Objekt zu erkennen. Darauf aufbauend ist der Studierende fähig, die in der Vorlesung vermittelten Inhalte zur Analye und Bewertung heranzuziehen, um das dynamische Verhalten im konkreten Fall richtig einschätzen zu können. Weiterhin ist es dem Studierenden möglich mit den in der Vorlesung erläuterten Maßnahmen das Schwingungsverhalten von dynamischen Systemen zu verbessern.

Teaching and Learning Methods:
Vorlesung, Übung, Bereitstellung funktionsfähiger Matlab-Simulationen zum Selbststudium, Bereitstellung eines Fragenkataloges (ca. 130 Fragen) als roter Faden zur Prüfungsvorbereitung

Media:
Präsentation (Tablet-PC), Skript online verfügbare Vorlage und auch als Vorlesungsmitschrift bzw. Übungsmitschrift

Handouts zu mathematischen Grundlagen

Videos von Praxisbeispielen und Animationen zu Schwingungsvorgängen

Reading List:
Dresig, H.; Holzweißig, F.: Maschinendynamik. Springer-Verlag Berlin Heidelberg, 9., neu bearbeitete Auflage 2009, mit 60 Aufgaben und Lösungen Gasch, R.; Nordemann, R.; Pfützner, H.: Rotordynamik. Springerverlag Berlin u.a., 2., vollst. neubearb. und erw.
Auflage 2002

Responsible for Module:
Rixen, Daniel; Prof. Dr.

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

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

Specialization in Technology: Mechanical Engineering (major) | Technik-Schwerpunkt: Maschinenwesen Vertiefungsmodule (major)

Module Description

MW0628: Energy and Economy | Energie und Wirtschaft

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
In a written exam (process time 60 min), it will be examined whether the students have understood the content conveyed regarding energy economy and can apply it to simple problems of the energy economy as well as energy conversion and transport.
No tools are allowed in the test. Task types are knowledge and understanding questions e.g. on basics of global trading with primary energy sources as well as their conversion to other energy forms (heat, power...) and the transport of the energy sources, short calculations e.g. on profitability calculation and drawing diagrams on energy policy but also on technological topics. The exam will be in German, English answers are possible after consulting the lecturer.

The final score consists of the following elements:
- 100% final examination

Repeat Examination:
Next semester

(Recommended) Prerequisites:
As the energy production technology itself is less treated, it is advisable to attend basic lectures such as energy systems 1 and sustainable energy systems in advance.

Content:
The lecture “Energy and Economics” deals with current issues of energy supply, economics and social impacts. Since the fundamental energy generation technologies are not in the main focus, it is recommended to attend lectures like “Energy Systems” in advance. The lecture and the exam

is held in German language. Involving external experts from industry the following topics are presented and discussed:
- Fundamentals of energy supply
- Commodity markets and world trade in primary energy
- Power trading
- Energy conversion concepts
- Methods of economic calculation
- Efficiency factors of power plants
- Governmental intervention in the market and liberalization
- Importance of energy-intensive companies to the economy
- Heat generation and supply
- Emissions and related costs
- Requirements for future energy systems

Intended Learning Outcomes:
After successful participation in the lecture, students are able to understand the essential functioning and correlations of the energy markets. They can apply the methods of cost-effectiveness calculation to energy-related questions. The functioning of the electricity market is understood and can be reproduced. The basic principles of global trade in primary energy carriers as well as their transformation into other energy forms (heat, electricity ...) and the transport of energy carriers can be discussed and analyzed.

Teaching and Learning Methods:
Frontal teaching, with media support by a PowerPoint presentation to disseminate knowledge with the aim of reproducing and discussing essential functions and relationships of the energy markets. Interactive exercises to deepen what has been learned, for example on the calculation of profitability. Interactive quiz to ensure the level of knowledge (At the beginning of each lecture the contents of the previous lecture are repeated).
During the semester, professional deliberations should be carried out by reading and editing book sections and / or paper articles as well as calculating simple exercises. The articles and tasks to be read are discussed / presented in the lecture and are also part of the exam.

Media:
Lecture, presentation (script), panel presentation, exercises

Reading List:
1: Erneuerbare Energien und Klimaschutz: Hintergründe – Techniken und Planung – Ökonomie und Ökologie –Energiewende, Volker Quaschning, Carl Hanser Verlag, München, 6. aktualisierte Auflage, 2021
2: Praxisbuch Energiewirtschaft: Energieumwandlung, -transport und -beschaffung, Übertragungsnetzausbau und Kernenergieausstieg, Panos Konstantin, VDI- Buch, Springer-Verlag GmbH, 4. aktualisierte Auflage, 2017

Responsible for Module:
Spliethoff, Hartmut; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Energie und Wirtschaft (Vorlesung, 2 SWS)
Wieland C [L], Mörtenkötter H, Wieland C
For further information in this module, please click campus.tum.de or here.

Module Description

MW1902: Industrial Automation | Automatisierungstechnik

Version of module description: Gültig ab summerterm 2020

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

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

Description of Examination Method:
Aktueller Hinweis angesichts des eingeschränkten Präsenzbetriebs auf Grund der CoViD19-Pandemie:
Sofern die Rahmenbedingungen (Hygiene-, Abstandsregeln etc.) für eine Präsenzprüfung nicht vorliegen, kann gemäß §13a APSO die geplante Prüfungsform auf eine mündliche, schriftliche oder elektronische Fernprüfung umgestellt werden. Die Entscheidung über diesen Wechsel wird möglichst zeitnah, spätestens jedoch 14 Tage vor dem Prüfungstermin durch die Prüfungsperson nach Abstimmung mit dem zuständigen Prüfungsausschuss bekannt gegeben.

Die Modulprüfung besteht aus einer Prüfungsleistung in Form einer schriftlichen Klausur (90 Minuten). Die Modulnote entspricht der Note der Prüfungsleistung.
Die verbindlichen Regularien, Richtlinien und Rahmenbedingungen über die Prüfungsleistung werden immer zu Beginn der Lehrveranstaltung und des jeweiligen Semesters bekannt gegeben.

Die Studierenden entwerfen in der Prüfung Modelle zur Beschreibung automatisierungstechnischer Anlagen und Prozesse aus verschiedenen Sichten der Automatisierungstechnik (z. B. R&I-Fließbilder oder anlagenspezifische Zustandsdiagramme). Hierbei wird die Anwendung von Modellierungsmethoden und den dahinterliegenden Sprachkonstrukten geprüft (z. B. formalisierte Prozessbeschreibung nach VDI/VDE 3682).
Darüber hinaus verwenden die Studierenden spezielle Modellinformationen, um anhand von Auszeichnungssprachen strukturierte Programme für geeignete Anwendungsfälle der Automatisierungstechnik zu entwerfen (z. B. nach den Sprachen der IEC 61131-3). Die Studierenden klassifizieren und illustrieren nach verschiedenen Verfahren und bewerten Sequenzen gegebener Abläufe der Feldbuskommunikation. Darüber hinaus beurteilen sie die Aspekte der Zuverlässigkeit und Sicherheit automatisierungstechnischer Anlagen anhand zu berechnender Kennwerte. Gestaltungselemente für die Mensch-Maschine-Schnittstellen werden anhand von Anwendungsproblemen geplant und charakterisiert, sowie resultierende Reaktionszeiten durch Berechnungen nachgewiesen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlagen der modernen Informationstechnik

Content:
Das Modul behandelt die zur Automatisierung von Maschinen und Anlagen eingesetzten informationstechnischen Komponenten. Sie gibt dazu zunächst einen Überblick über die vorhandenen Automatisierungsstrukturen und die dazu entsprechenden Systeme sowie Geräte. Die Modellierung der Anlagen bzw. Prozesse wird anhand verschiedener Modellierungsmethoden (z. B.: R&I-Fließbilder) behandelt. Die Strukturierung und Transformation in anwendbare Steuerungsprogramme wird auf Basis von Auszeichnungssprachen gelehrt. Weitere Inhalte sind die Schnittstellen zwischen dem technischen Automatisierungssystem und dem technischen Prozess in Form von Aktoren und Sensoren sowie zwischen Mensch und Maschine durch das Mensch-Maschine-Interface (MMI). Behandelt werden zudem die Themengebiete "Industrielle Kommunikation" (z. B. Feldbussysteme) und die "Steuerung von Maschinen mittels der Sprachen der IEC 61131-3". Wichtiger Bestandteil der Lehrveranstaltung ist das Zusammenwirken der verschiedenen Automatisierungsbausteine im Gesamtsystem. Hierzu wird das methodische Vorgehen bei der Konzeption, Realisierung, dem Test und der Inbetriebnahme von Automatisierungssystemen sowie deren Beurteilung hinsichtlich Sicherheit und Zuverlässigkeit behandelt. Abgerundet wird die Vorlesung durch eine Einführung in Manufacturing Execution Systems (MES). Das Modul ist weiterhin auf das Erlernen von methodischem Vorgehen sowie den Bezug und die praktische Anwendung aktueller Forschungsergebnisse in der Automatisierungstechnik ausgerichtet.

Intended Learning Outcomes:
Die Studierenden können nach Abschluss des Moduls das Zusammenwirken der verschiedenen Aspekte der Automatisierungstechnik im Kontext des Gesamtsystems bewerten. Daraus ableitend sind die Studierenden in der Lage Anforderungen zu entwickeln. Die Studierenden werden befähigt, sowohl den technischen Prozess als auch das dazugehörige automatisierungstechnische System mit geeigneten Methoden und Modellierungssprachen anzuwenden (z. B. R&I-Fließbilder, Zustandsdiagramme, etc.).
Darüber hinaus können sie die Mechanismen von industriellen Echtzeit-, Bus- und Betriebssystemen selbst einsetzen und Automatisierungssysteme mit den IEC 61131-3 konformen Sprachen programmieren. Außerdem sind sie in der Lage, die Funktionsweise sowie das Wirkprinzip von Aktoren und Sensoren für die Analyse bzw. Planung von Automatisierungssystemen zu bewerten.
Die Studierenden werden zudem die Fähigkeit erwerben, die Zuverlässigkeit und Sicherheit automatisierungstechnischer Anlagen zu analysieren und Mensch-Maschine-Schnittstellen unter Berücksichtigung weit verbreiteter und akzeptierter Gestaltungsrichtlinien selbstständig zu entwickeln. Darüber hinaus können sie die Informationsflüsse eines Manufacturing Execution Systems (MES) auf Basis von spezifischen Modellen planen.

Teaching and Learning Methods:
In der Vorlesung werden durch Vortrag und Präsentation die theoretischen Zusammenhänge erläutert und anhand von Fallstudien aus der realen Praxis vorgestellt. Mittels Präsentationen wird die frontale Wissensermittlung ermöglicht. Die dazugehörige Übung umfasst das Lösen von entsprechenden Aufgaben (von Verständnisfragen über Rechenaufgaben bis hin zur Anwendung geeigneter Methoden und Modellierungssprachen). Diskussionsrunden, Gruppenarbeit und aktive Teilnahme ermöglichen ein tieferes Verstehen der Vorlesungsinhalte und deren Anwendung.

Media:
Präsentation, Tafelübungen, praktische Übungen (Modellieren, Programmieren), Videomaterial zum tieferen Verständnis

Reading List:
- Vogel-Heuser, B.: Systems Software Engineering. Angewandte Methoden des Systementwurfs für Ingenieure. Oldenbourg, 2003. ISBN 3-486-27035-4.
- Partsch, Helmut: Requirements Engineering systematisch, Modellbildung für softwaregestützte Systeme, Springer, 1998.
- Zöbel, D.; Albrecht, W.: Echtzeitsysteme. Grundlagen und Techniken. International Thomson Publishing, 1995.
- Stevens, R.; Brook, P.; Jackson, K.; Arnold, S.: Systems Engineering. Coping with Complexity. Prentice Hall Europe, 1998.
- Tiegelkamp, M.; John, K.-H.: SPS Programmierung mit IEC1131-3. Springer-Verlag, Berlin, Heidelberg 1997
- Frevert, L.: Echtzeit-Praxis mit PEARL. Leitfäden der angewandten Informatik. B.G. Teubner, Stuttgart, 1985.
- Lauber, R.; Göhner, P.: Prozessautomatisierung 1. Springer-Verlag, Berlin, Heidelberg 2013.
- Friedenthal, S.; Moore, A.; Steiner, R.: A Practical Guide to SysML; Elsevier, 2011.

Responsible for Module:
Vogel-Heuser, Birgit; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Automatisierungstechnik 1 Zentralübung (Übung, 1 SWS)
Vogel-Heuser B

Automatisierungstechnik 1 (Vorlesung, 2 SWS)
Vogel-Heuser B, Wilch J
For further information in this module, please click campus.tum.de or here.

Specialization in Technology: Informatics (minor) | Technik-Schwerpunkt: Informatik Basismodule (minor)

Module Description

IN0001: Introduction to Informatics | Einführung in die Informatik

Version of module description: Gültig ab winterterm 2011/12

Module Level: Bachelor	**Language:** German	**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:
Type of Assessment: exam (120 minutes)

The exam takes the form of 120 minutes written test. Questions allow to assess acquaintance with concepts of Informatics and programming, small programming tasks assess the ability to conceive appropriate algorithmic solutions and realize concurrent applications.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Participants should attend IN0002 "Fundamentals of Programming (Exercises & Laboratory)" at the same time.

Content:
The module IN0001 is concerned with topics such as:
- Introduction
++ Basic notions: Problem - algorithm - program
++ Imperative programming constructs
- Syntax and semantics
++ Syntax of programming languages: regular expressions and contextfree grammers
++ Semantics of programs: control-flow graphs
- Basic data structures I
++ Numbers, strings, arrays
++ Insertion sort

- Recursion
++ Binary search
++ Patterns of recursion
- Basic data structures II
++ Objects, classes, methods
++ Lists, stacks, queues
- Object-oriented programming
++ Inheritance
++ Abstract classes and interfaces
++ Polymorphism
- Programming in the large (perspectives)
- Concurrency and Threads

Intended Learning Outcomes:
Upon successful completion of the module participants understand the essential concepts of computer science on a fundamental, practice-oriented, but scientific level.
Concepts of this kind are for example: Algorithms, syntax and semantics, as well as efficiency in terms of memory consumption or time.
Participants are then able to solve well-posed algorithmic problems and to implement basic distributed and concurrent applications in Java or a similar object-oriented language. They understand the underlying concepts and models and are therefore able to acquire skills in other imperative and object-oriented programming languages on their own.

Teaching and Learning Methods:
Lecture, combined with experimental assessment of examples at the computer and evaluation of further readings

Media:
Slide show, blackboard, online programming experiments, animations, lecture recording

Reading List:
Heinisch, Müller-Hofmann, Goll: Java als erste Programmiersprache, Teubner, 2007
Deitel, Harvey / Deitel, Paul: How to program Java Prentice-Hall, 2002
Flanagan, David: Java in a Nutshell O'Reilly, 2002
Bishop, Judith: Java gently Prentice-Hall, 2001
Eckel, Bruce: Thinking in Java Prentice-Hall, 2002

Responsible for Module:
Seidl, Helmut; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die Informatik (IN0001) (Vorlesung, 4 SWS)
Westermann R
For further information in this module, please click campus.tum.de or here.

Module Description

IN0004: Introduction to Computer Organization and Technology - Computer Architecture | Einführung in die Rechnerarchitektur

Version of module description: Gültig ab winterterm 2011/12

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

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

Description of Examination Method:
The examination will be conducted in written form as part of a 120 minute exam. Here, examples from different areas of machine oriented programming in Assembler, micro-programming, circuit design and hardware description languages will be used to assess the capability of the students to master such concepts of computer architectures. Answers to short questions about basic concepts in computer architecture must show that the candidates mastered these concepts. Support material is provided during the examination, no additional help is allowed.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
none

Content:
- Computer systems: basic architecture and organization: Von-Neumann-Computer, machine-instruction cycle, hardware-software interface
- The Instruction Set Architecture (ISA): functionality and machineoriented Assembler programming
- Micro-programmed implementation of machine instructions
- Circuits, sequential circuits, circuit design with a formal language using the example of VHDL
- Introduction to computer architecture: microprocessor architectures and systems, parallel and distributed systems, memory systems, I/O

Intended Learning Outcomes:
After attending this module students are able to understand computer systems as layered abstract machines. They get a first impression of the area of computer architectures and possess the following abilities:

They have learned to apply the main concepts of machine-oriented programming, microprogramming and circuit design. They understand the machine instruction cycles based on the underlying hardware at the register transfer level and they are able to classify computer architectures. The understand the basics of modern computer architecture.

Teaching and Learning Methods:
Using slide decks with animations, the lecture explains the basic concepts of computer architecture. This is supported by a concurrent series of central exercise sessions as well as small exercise groups, which explain the application of the material presented in the class. Homework allows the students to self-study the material. Solutions are then discussed both in the central exercise class as well as the smaller exercise groups. The ability to present their own solution as part of the exercise groups further aids in the understanding of the material and supports the students' ability to communicate.

Media:
Slides of lectures, exercise sheets with assignments, collections of assignments, other working material.

Reading List:
- Andrew S. Tanenbaum, Todd Austin: Rechnerarchitektur: Von der digitalen Logik zum Parallelrechner
- David A. Patterson, John L. Hennessy, Computer Organization and Design: The Hardware/ Software Interface
- Intel386 TM DX MICROPROCESSOR 32-BIT CHMOS MICROPROCESSOR WITH INTEGRATED MEMORY MANAGEMENT
- Beschreibung der mikroprogrammierbaren Maschine

Responsible for Module:
Schulz, Martin; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die Rechnerarchitektur (IN0004) (Vorlesung, 4 SWS)
Schulz M (Maiterth M), Wille R (Peham T)

Übungen zu Einführung in die Rechnerarchitektur - Gruppen Mo, Di, Mi (IN0004) (Übung, 2 SWS)
Schulz M [L], Maiterth M, Huseynli F, Peham T
For further information in this module, please click campus.tum.de or here.

Specialization in Technology: Informatics (major) | Technik-Schwerpunkt: Informatik Vertiefungsmodule (major)

Module Description

IN2101: Network Security | Network Security

Version of module description: Gültig ab winterterm 2011/12

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

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

Description of Examination Method:
The examination will take the form of a 75-minute examination.
Questions of comprehension and arithmetic tasks check the familiarity with the technologies and methods of cryptographic procedures and protocols and mechanisms for network security covered in the module.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
IN0009 Basic Principles: Operating Systems and System Software, IN0010 Introduction to computer networking and distributed systems

Content:
The course provides an introduction to the field of network security. Starting with possible threats and attack scenarios, requirements for providing specific security services are derived. After introducing the basic concepts of security mechanisms, the integration of security mechanisms into network architectures and network protocols are discussed. Security vulnerabilities of existing network architectures are also discussed.
As a basis for the realization of security mechanisms, cryptographic algorithms (in particular symmetric cryptography, public key cryptography and cryptographic hash functions) are presented. Afterwards, the basics and methods for security protocols for authentication, authorization, access control, message integrity, confidentiality and non-repudiation are discussed. Subsequent sections present specific security mechanisms, in particular of the TCP/IP protocol family. The standard

examples include PKI, Kerberos, IPSec, and TLS, Firewall-architectures and Intrusion Detection Systems.

Intended Learning Outcomes:
Participants understand security goals for the Internet and the components in which communication protocols are implemented. They understand the possibilities available to attackers in the network. They understand the protection offered by cryptographic and network security mechanisms, and have the knowledge to apply network security protocols and implement architectures that can achieve specific security goals.

Teaching and Learning Methods:
Lecture for content transfer, as well as tasks for self-study in order to deepen the subject, as well as programming challenges to test and apply the learned knowledge.

Media:
Lecture slides, whiteboard, exercise sheets, demos

Reading List:
- R. Bless, S. Mink, E.-O. Blaß, M. Conrad, H.-J. Hof, K. Kutzner, M. Schöller: "Sichere Netzwerkkommunikation", Springer, 2005, ISBN: 3-540-21845-9
- Niels Ferguson, B. Schneier: ?Practical Cryptography?, Wiley, 1st edition, March 2003.
- G. Schäfer. Netzsicherheit ? Algorithmische Grundlagen und Protokolle. Soft cover, 422 pages, dpunkt.verlag, 2003.

Additional references to articles and other resources are given in the slides.

Responsible for Module:
Carle, Georg; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Netzsicherheit (IN2101) (Vorlesung mit integrierten Übungen, 4 SWS)
Carle G [L], Carle G, Kinkelin H, von Seck R, Rezabek F, Aulbach J, Sattler P, Steger L
For further information in this module, please click campus.tum.de or here.

Module Description

IN2406: Fundamentals of Artificial Intelligence | Fundamentals of Artificial Intelligence

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
Written exam at the end of the semester lasting 90min. The questions will cover most of the learned material and are typically shorter than the problems solved in the exercise, but similar in difficulty.
As an incentive to create artificial intelligence oneself, we provide programming challenges: if students solve a required number of programming challenges, they obtain a 0.3 grade bonus for their exam.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Previous attendance of
- IN0007 Fundamentals of Algorithms and Data Structures
- IN0015 Discrete Structures
- IN0018 Discrete Probability Theory
is beneficial. However, all content is taught from ground up and the listed lectures are not essential. Students who have not attended these lectures will have to invest additional time.

Content:
- Task environments and the structure of intelligent agents.
- Solving problems by searching: breadth-first search, uniform-cost search, depth-first search, depth-limited search, iterative deepening search, greedy best-first search, A* search.
- Constraint satisfaction problems: defining constraint satisfaction problems, backtracking search for constraint satisfaction problems, heuristics for backtracking search, interleaving search and inference, the structure of constraint satisfaction problems.

- Logical agents: propositional logic, propositional theorem proving, syntax and semantics of first-order logic, using first-order logic, knowledge engineering in first-order logic, reducing first-order inference to propositional inference, unification and lifting, forward chaining, backward chaining, resolution.
- Bayesian networks: acting under uncertainty, basics of probability theory, Bayesian networks, inference in Bayesian networks, approximate inference in Bayesian networks.
- Hidden Markov models: time and uncertainty, inference in hidden Markov models (filtering, prediction, smoothing, most likely explanation), approximate inference in hidden Markov models.
- Rational decisions: introduction to utility theory, utility functions, decision networks, the value of information, Markov decision processes, value iteration, policy iteration, partially observable Markov decision processes.
- Learning: types of learning, supervised learning, learning decision trees, reinforcement learning.
- Introduction to robotics: robot hardware, robotic perception, path planning, planning uncertain movements, control of movements, application domains.

Intended Learning Outcomes:
After attending the module, you are able to create artificial intelligence on a basic level using search techniques, logics, probability theory and decision theory. Your learned abilities will be the foundation for more advanced topics in artificial intelligence. In particular, you will acquire the following skills:
- You can analyze problems of artificial intelligence and judge how difficult it is to solve them.
- You can recall the basic concepts of intelligent agents and know possible task environments.
- You can formalize, apply, and understand search problems.
- You understand the difference between constraint satisfaction and classical search problems as well as apply and evaluate various constraint satisfaction approaches.
- You can critically assess the advantages and disadvantages of logics in artificial intelligence.
- You can formalize problems using propositional and first-order logic.
- You can apply automatic reasoning techniques in propositional and first-order logic.
- You understand the advantages and disadvantages of probabilistic and logic-based reasoning.
- You can apply and critically asses methods for probabilistic reasoning with Bayesian networks and Hidden Markov Models.
- You understand and know how to compute rational decisions.
- You have a basic understanding on how a machine learns.
- You know the basic areas and concepts in robotics.

Teaching and Learning Methods:
The module consists of a lecture and exercise classes. The content of the lecture is presented via slides, which are completed during the lecture using the blackboard and/or an electronic writing pad. Students are encouraged to additionally study the relevant literature. In the exercise classes, the learned content is applied to practical examples to consolidate the content of the lecture. Students should ideally have tried to solve the problems before they attend the exercise. To encourage more participation, students are regularly asked questions or encouraged to participate in online polls. As an incentive to create artificial intelligence oneself, we provide programming

challenges: if students solve a required number of programming challenges, they obtain a 0.3 grade bonus for their exam.

Media:
Slides, blackboard, electronic writing pad, exercise sheets;

Reading List:
- P. Norvig and S. Russell: Artificial Intelligence: A Modern Approach, Prentice Hall, 4th edition. (English version)
- P. Norvig and S. Russell: Künstliche Intelligenz: Ein moderner Ansatz, Pearson Studium, 4. Auflage. (German version)
- W. Ertel: Grundkurs Künstliche Intelligenz: Eine praxisorientierte Einführung, Springer, 4. Auflage.
- P. Zöller-Greer: Künstliche Intelligenz: Grundlagen und Anwendungen, composia, 2. Auflage.
- D. L. Poole and A. K. Mackworth: Artificial Intelligence: Foundations of Computational Agents, Cambridge University Press.
- P. C. Jackson Jr: Introduction to Artificial Intelligence, Dover Publications.

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

Courses (Type of course, Weekly hours per semester), Instructor:
Fundamentals of Artificial Intelligence (IN2406) (Vorlesung mit integrierten Übungen, 5 SWS)
Althoff M [L], Althoff M, Gaßner J, Kulmburg A, Meyer E, Würsching G
For further information in this module, please click campus.tum.de or here.

Specialization in Technology: Chemistry (minor) | Technik-Schwerpunkt: Chemie Basismodule (minor)

Required Modules | Pflichtbereich

Module Description

CH1090: Introduction to Organic Chemistry | Einführung in die Organische Chemie

Version of module description: Gültig ab summerterm 2018

Module Level: Bachelor	**Language:** German	**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:
Eine Prüfungsleistung wird in Form einer Klausur (90 Minuten) erbracht. In dieser soll nachgewiesen werden, dass in begrenzter Zeit und ohne Hilfsmittel ein Problem erkannt wird und Wege zu einer Lösung gefunden werden können. Dabei sollen die Studierenden zeigen, dass sie die organische Chemie wichtiger Verbindungen aus Natur und Technik bewerten können.
Sie verstehen Aufbauprinzipien und Eigenschaften der grundlegenden Naturstoffklassen. Die Studierenden sind vertraut mit den grundlegenden Reaktionsweisen organischer Verbindungen und können diese wiedergeben. Die Prüfungsfragen gehen über den gesamten Modulstoff.
Die Antworten erfordern teils eigene Berechnungen und Formulierungen teils Ankreuzen von vorgegebenen Mehrfachantworten.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Lectures in Basic and inorganic chemistry.

Content:
Introduction:
What is Organic Chemistry ? Structural units, alkyl chains, functional groups, structural principles, isomerism, geometry, chirality

Hydrocarbons:
Alkanes, cycloalkanes, alkenes, alkynes, aromaticity, aromatics

Oxygen compounds :
Polar bond, alcohols, ethers, aldehydes, ketones, carboxylic acids, esters

Petroleum, petrochemicals, fuels, triglycerides:
Petroleum and petrochemicals, fats, oils, triglycerides, fatty acids, modern fuels, bioethanol, biodiesel, synthetic fuels

Water and organic molecules:
The structure of water, entropy, hydrophilicity, hydrophobicity, polar and non-polar solvents, surfactants, fat hydrolysis, phospholipids

Organic dyes and pigments:
Creation and perception of light and color, chromophores, natural organic dyes indigo and madder, triphenylmethane-, tar-, azodyes, phthalocyanines, modern high-performance pigments, optical brighteners

Carbohydrates:
Glucose and isomeric sugar, hemiacetal formation and pyranoses, mono-, di-, and polysaccharides, starch, cellulose

Proteins:
Amino acids and peptide bond, peptides, proteins, primary, secondary, tertiary structure, the key - lock principle, fibrous proteins: keratins, collagen

Plastics:
Thermoplastics, elastomers and thermosets, polymer types, polymerization and the polymerisates, polycondensation and polycondensates , polyaddition and polyadducts

In-depth knowledge:
Industrial organic chemistry: pharmaceuticals, evaluation of chemical reactions: yield and atom economy, terpenes, DNA and RNA

Intended Learning Outcomes:
After participating in the module, the students are able to evaluate the organic chemistry of important compounds in nature and technology. They understand structural principles and properties of the basic classes of natural products. Students are familiar with the basic modes of reaction of organic compounds.

Teaching and Learning Methods:
The module consists of a lecture with accompanying exercises. The contents are taught in lecture and through presentations. Students should be encouraged to substantive discussion of the issues

and to study advanced literature. Exercises are given in correlation to the lecture progress and will be discussed centrally after a given processing time.

Media:
Script, presentation, exercise sheets.

Reading List:
H. Beyer, W. Francke, W. Walter, "Lehrbuch der Organischen Chemie", lecture script

Responsible for Module:
Fontain, Eric; PD Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die Organische Chemie, Übung (CH1090) (Übung, 1 SWS)
Fontain E (Stegbauer S)

Einführung in die Organische Chemie (CH1090) (Vorlesung, 3 SWS)
Fontain E (Stegbauer S)
For further information in this module, please click campus.tum.de or here.

Module Description

CH1091: Basic Principles of Physical Chemistry 1 | Grundlagen der Physikalischen Chemie 1

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
The examination is done in the form of a written exam (90 minutes). In this, it should be demonstrated that in limited time and without aids a problem is identified and ways to a solution can be found. To demonstrate the learning outcomes achieved, students should recognize the statistical nature of thermodynamics and kinetics and remember the Gibbsian formalism. The students understand the role of state functions and their function in thermochemistry, equilibrium and kinetics and can explain this. Furthermore, the students show that they can apply the solved equations to concrete problems of thermodynamics and kinetics. They know standard phenomena of thermodynamics and kinetics and can formally analyze them. The exam questions go over the entire module material. The answers partly require own calculations and phrasing, partly ticking of predetermined multiple answers.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Introduction to General chemistry

Content:
1) Equations of state for ideal and real gases (intermolecular interactions, van der Waals equation, and virial developement) .
2) Kinetic theory of gases , specific heat, translational, rotational and vibrational degrees of freedom, Boltzmann and Maxwell distribution (including basic statistical considerations).
3) 1 Law: Internal energy and enthalpy as a state function, isothermal and adiabatic processes, Joule-Thomson effect, Thermochemistry: set of Hess, Kirchhoff's sentence, Haber-Born cycle.
4) 2 Law: reversible and irreversible processes, Carnot cycle, entropy, 3. Law , phase transition and Trouton'sche rule, efficiency, heat pump, free energy / free enthalpy (maximum work).

5) Equilibrium: partial molar quantities, chemical potential, Herny's and Raoult law, law of mass action, thermodynamic and other equilibrium constants, pressure dependence, Le Chatelier, van't Hoff equation, activity.
6) Formal kinetics , first and second order, parallel and consecutive reactions, pseudo first order, enzyme kinetics, relaxation to equilibrium, steady state.
7) Theoretical treatment of kinetics: Arrhenius law, theory of the transition state.

Intended Learning Outcomes:
After attending this module, students should be able to: 1) recognize the statistical nature of thermodynamics and kinetics, and to remember the Gibbs formalism. 2) understand and explain the importance of state functions and its function in the thermochemistry , the equilibrium and kinetics a. 3) apply and solve the developed equations to concrete problems of thermodynamics and kinetics. 4) analyze formally standard phenomena of thermodynamics and kinetics.

Teaching and Learning Methods:
The module consists of a lecture (3 SWS) and an accompanying exercise (1 SWS). The contents of the course will be taught in lecture and through presentations and animation, whereby the relationship between formal tool, microscopic theorie and diversity is explained. Practice sheets containing specific Problems are ditributed weekly for self study. In the practice sessions the self found solutions are discussed and the tasks are solved and commented afterwards. Detailed solutions can be found on the internet and include: 1) a sketch of the solution approach, 2) a complete solution with all steps of calculation and references to typical failures, 3) advanced information material to stimulate self-study.

Media:
Presentation on blackboard and projector, script

Reading List:
P.W. Atkins u. J. de Paula, Physikalische Chemie, WILEY-VCH Verlag, 2006.
P.W. Atkins, C.A. Trapp,M.P. Cady, P. Marshall, C. Giunta. Arbeitsbuch Physikalische Chemie, WILEY-VCH Verlag, 2007.
J. Tinocio Jr. , K. Sauer, J.C. Wang, Physical Chemistry, Prentice Hall (1995).

Responsible for Module:
Bachmann, Annett; Dr. phil.

Courses (Type of course, Weekly hours per semester), Instructor:
Grundlagen der Physikalischen Chemie 1, Übung (CH1091/CH7201 bzw. CH6000/CH0144) (Übung, 1 SWS)
Bachmann A

Grundlagen der Physikalischen Chemie 1 (CH1091/CH7201 bzw. CH6000/CH0144) (Vorlesung, 3 SWS)
Bachmann A

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

Module Description

CH6202: General and Inorganic Chemistry | Allgemeine und Anorganische Chemie

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
Die Prüfungsleistung wird schriftlich, in Form einer 90-minütigen Klausur erbracht. In dieser sollen die Studierenden nachweisen, dass sie in begrenzter Zeit und ohne Hilfsmittel konkrete Fragestellungen der Allgemeinen und Anorganischen Chemie (beispielsweise pH-Wert-Berechnung oder stoffchemisches Wissen) erkennen und diese lösen können. Die Prüfungsfragen gehen über den gesamten Modulstoff. Die Antworten erfordern entweder das im Modul erlernte Wissen oder daraus abgeleitete Berechnungen.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Keine Voraussetzungen notwendig.

Content:
In diesem Modul werden die grundlegenden Begriffe der Allgemeinen Chemie (Einheiten und Stoffgrößen der Chemie) behandelt. Nachfolgend erlernen die Studierenden, nach welchen Prinzipien und Methoden chemische Reaktionen, Rechnungen und Fragestellungen zu bearbeiten sind. Hierbei behandelt das Modul beispielsweise das Aufstellen von Reaktionsgleichungen, die Berechnungen von pH-Werten, von Einwaagen, von Konzentrationen sowie die Grundlagen der Elektrochemie. Neben den allgemeinen Aspekten der Chemie steht weiterhin die Anorganische Stoffchemie im Vordergrund des Moduls. Dabei werden überwiegend die Hauptgruppenelemente des Periodensystems behandelt. Den Studierenden wird stoffspezifisch das unterschiedliche Verhalten der Elemente vermittelt (Reaktivität von Elementen und Verbindungen). Es werden von jedem Element wichtige und anwendungsrelevante Verbindungen besprochen. Hierbei wird auch auf wichtige Teilaspekte für die Studierenden des Umweltingenieurwesens näher eingegangen (z. B. Treibhaus- und Umweltproblematik verschiedener Stoffe, Wasserchemie, etc).

Intended Learning Outcomes:
Nach der Teilnahme am Modul "Allgemeine und Anorganische Chemie" sind die Studierenden in der Lage, die grundlegenden Fachbegriffe der Chemie zu nennen und die wichtigsten Einheiten und Stoffgrößen zu erkennen, zu verstehen und selber anzuwenden. Weiterhin sind die Studierenden in der Lage, chemische Reaktionsgleichungen aufzustellen und mögliche Probleme in der Reaktivität der Stoffe zu erkennen und zu benennen und zugehörige Rechnungen (pH-Wert, Konzentration oder Löslichkeit) zu lösen. Die Studierenden verstehen die Grundlagen der Elektrochemie und sind mit der Stoffchemie der Hauptgruppenelemente des Periodensystems vertraut. Die Studierenden wissen, dass Elemente unterschiedliche Eigenschaften besitzen und, in Verbindungen, unterschiedlich reagieren. Darüber hinaus sind die Studierenden nach der Teilnahme am Modul in der Lage, die Prinzipien und Methoden der Chemie, welche sich überwiegend in den analytischen Denkweisen und den angewandten Rechnungen widerspiegeln, zu verstehen und anzuwenden. Weiterhin entwickeln die Studierenden einen analytischen Blick für aktuelle umweltpolitische Probleme (z. B. Treibhaus- und Umweltproblematik verschiedener Stoffe, Wasserchemie, etc).

Teaching and Learning Methods:
Das Modul besteht aus einer Vorlesung (2 SWS) mit begleitender Übung (1 SWS). Die Inhalte des Moduls werden in der Vorlesung im Vortrag und durch Präsentationen vermittelt. Hierbei werden die Studierenden über die Grundlagen der Chemie zu weiterführenden Inhalten herangeführt. Der Lernstoff wird stufenweise vermittelt, sodass die Studierenden auf dem zuvor erlerntem Wissen aufbauen können. Zur Festigung der Lernergebnisse werden in der begleitenden Übung Aufgaben bearbeitet, die zeitgleich zur inhaltlichen Auseinandersetzung mit den Themen und zum Studium weiterführender Literatur anregen sollen. Des Weiteren dienen ausgegebene Hausaufgabe zur freiwilligen Festigung des Lernstoffs, bzw. zur erweiterten Übung der Modulinhalte.

Media:
Vortrag, Präsentationen, Tafelanschrieb, Übungsaufgaben

Reading List:
Mortimer/Mu#ller: Chemie, Das Basiswissen der Chemie, 13. Auflage, 2019 (Thieme)
Riedl/Meyer: Allgemeine und Anorganische Chemie, 12. Auflage, 2018 (de Gruyter)

Responsible for Module:
Gädt, Torben; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Allgemeine und Anorganische Chemie für UIW und GEO (CH6202a) (Vorlesung, 2 SWS)
Gädt T (Rindle O)

Allgemeine und Anorganische Chemie für UIW und GEO, Übung (CH6202b) (Übung, 1 SWS)
Gädt T, Rindle O
For further information in this module, please click campus.tum.de or here.

Electives | Wahlbereich

Module Description

CH0106: Biology for Chemists | Biologie für Chemiker

Version of module description: Gültig ab summerterm 2018

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

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

Description of Examination Method:
Die Prüfungsleistung wird schriftlich in Form von einer 90-minütigen Klausur erbracht. In dieser soll nachgewiesen werden, dass in begrenzter Zeit und ohne Hilfsmittel die Lernergebnisse des Moduls (z.B. die Grundstruktur von Biomolekülen und der Zellaufbau; wichtige biochemische Vorgänge innerhalb einer Zelle; Beziehung zwischen der chemischen Struktur und der (biologisch / biochemischen) Wirkung von organischen Molekülen; Protein-Biosynthese sowie die Grundlagen der Evolution deren molekulare Grundlagen) wiedergegeben und Fragestellungen zum Inhalt des Moduls eigenständig bearbeitet werden können. Die Prüfungsfragen gehen über den gesamten Modulstoff. Die Antworten erfordern eigene Berechnungen und Formulierungen und können teilweise die Auswahl von vorgegebenen Mehrfachantworten beinhalten.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Keine

Content:
Der Inhalt des Moduls umfasst die Grundlagen der Biochemie: Chemische Grundlagen; Moleküle des Lebens (Stoffklassen: Kohlenhydrate, Lipide, Nukleinsäuren, Aminosäuren); Grundlagen von Leben; Energie; genetische Information; DNA; Genom; Replikation; Transkription; Translation; Zellaufbau (Zytologie); Zytoskelett; Zell-Zell-Interaktionen (Gewebe); Zellzyklus; Fortpflanzung; Vererbung und Evolution; chemische Evolution; Ökologie; Immunologische Grundlagen; Grundlagen der DNA-Rekombinationstechnik.

Intended Learning Outcomes:
Nach der erfolgreichen Teilnahme am Modul verstehen die Studierenden den Aufbau von organischen Verbindungen und die wichtigsten biochemischen Vorgänge innerhalb einer Zelle. Die Studierenden erinnern sich an den Aufbau von Zellen sowie an den Aufbau der für die Biochemie und organischen Chemie relevanten Stoffklassen und die chemischen funktionellen Gruppen. Die Studierenden verstehen die Beziehung zwischen der chemischen Struktur und der (biologisch/biochemischen) Wirkung von organischen Molekülen. Die Studierenden erinnern sich an die Protein-Biosynthese sowie die Grundlagen der Evolution und verstehen deren molekulare Grundlagen. Insgesamt haben die Studierenden nach der erfolgreichen Teilnahme am Modul einen Überblick über die strukturellen und funktionellen Grundzüge von Biomolekülen.

Teaching and Learning Methods:
Das Modul besteht aus der Vorlesung Biologie für Chemiker (2 SWS) und einer begleitenden Übungsveranstaltung (1 SWS). Die Inhalte der Vorlesung werden im Vortrag, Präsentationen und Tafelanschriften vermittelt. Begleitend sollen die Studierenden die behandelten Inhalte durch Durchsicht eines geeigneten Lehrbuchs weiter vertiefen. In der Übung werden die Inhalte der Vorlesung durch die Bearbeitung eines Fragenkatalogs ebenfalls weiter vertieft.

Media:
Vortrag mittels PowerPoint, Tafelanschrift, Skriptum, Übungsaufgabensammlung, Filme

Reading List:
Als Lehrbuch begleitend zum Modul: Campell/Reece, Biologie, Pearson Education und Alberts/ Johnson/Lewis/Raff/Roberts/Walter, Molekularbiologie der Zelle, Wiley VCH.

Responsible for Module:
Buchner, Johannes; Prof. Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Biologie für Chemiker (CH0106) (Vorlesung mit integrierten Übungen, 3 SWS)
Buchner J [L], Haslbeck M
For further information in this module, please click campus.tum.de or here.

Module Description

CH0107: Analytical Chemistry | Analytische Chemie

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
Die Prüfungsleistung wird in Form einer Klausur (60 Minuten) erbracht. In dieser soll nachgewiesen werden, dass in begrenzter Zeit und ohne Hilfsmittel die verschiedenen Schritte moderner Analytik von der Probenahme bis zur Auswertung erkannt und gängige instrumentelle Analyseverfahren erinnert werden können. Die Antworten erfordern teils eigene Berechnungen und Formulierungen teils Ankreuzen von vorgegebenen Mehrfachantworten.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Grundwissen in Chemie und Physik.

Content:
Der Analytische Prozess: Probennahme, Probenvorbereitung, Detektions- und Bestimmungsverfahren, Validierung der Ergebnisse, Qualitätssicherung. Instrumentelle Analytik, u.a. AAS, OES, RFA, MS, Kopplungstechniken. Illustrative Beispiele moderner Elementanalytik.

Intended Learning Outcomes:
Nach der Teilnahme am Modul sind die Studierenden in der Lage, die einzelnen Schritte einer chemischen Analyse von Probenahme, Probenaufbereitung, Messung, Auswertung und Validierung zu erinnern und deren Eigenheiten und Wichtigkeit zu verstehen und anzuwenden. Sie können verschiedene moderne Analyseverfahren wie AAS, OES, RFA, MS und Kopplungsverfahren benennen und erklären.

Teaching and Learning Methods:
Das Modul besteht aus einer Vorlesung deren Inhalt im Vortrag und durch Präsentationen vermittelt wird. Studierende werden zur inhaltlichen Auseindersetzung mit der Thematik und zum Studium der Literatur angeregt.

Media:
Bücher, Online-Skript

Reading List:
Skoog, Douglas A., Holler, F. James, Crouch, Stanley R. Niessner, R. (Hrsg.), Instrumentelle Analytik Grundlagen - Geräte Anwendungen. Springer 2013, 6. Auflage.
Harris, Daniel C., Werner, Gerhard, Werner, Tobias (Hrsg.), Lehrbuch der Quantitativen Analyse. Springer 2014, 8. Auflage.

Responsible for Module:
Strittmatter, Nicole; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Analytische Chemie (CH0107) (Vorlesung, 2 SWS)
Strittmatter N (Ivleva N)
For further information in this module, please click campus.tum.de or here.

Specialization in Technology: Chemistry (major) | Technik-Schwerpunkt: Chemie Vertiefungsmodule (major)

Module Description

CH3153: Construction Chemistry 1 | Bauchemie 1

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
Die Prüfungsleistung wird in Form einer Klausur (90 Minuten) erbracht. Hierbei sollen die Studierenden zeigen, dass sie in der Lage sind die Vor- und Nachteile sowie die Anwendungseigenschaften typischer bauchemischer Zusatzmittel (wie z.B. Verflüssiger, Fließmittel, Verdickungsmittel und Wasserretentionsmittel) zu benennen und komplexe Fragestellungen hierzu lösen zu können. Darüber hinaus sollen die Studierenden in der Prüfung aufzeigen, dass sie die industrielle Herstellung dieser Zusatzmittel verstehen und schriftlich wiedergeben können. Zudem beschäftigt sich ein Teil der Prüfung mit dem detaillierten Wirkmechanismus dieser Zusatzmittel, den die Studierenden anhand der spezifischen Molekülstruktur herleiten und ausführlich diskutieren sollen. Die Prüfungsfragen umfassen den gesamten Modulstoff. Neben frei formulierten Fragen können auch kurze Rechenaufgaben Teil der Klausur sein. Es sind keine Hilfsmittel erlaubt.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fortgeschrittene Kenntnisse in allgemeiner und anorganischer Chemie, Grundkenntnisse der Polymerchemie.

Content:
Das Modul stellt die Werkstoffkunde der Baumaterialien aus einer chemischen Perspektive dar. Dies umfasst eine kurze Darstellung des mechanischen Verhaltens von festen Körpern, sowie von plastisch verformbaren Werkstoffen, insbesondere Suspensionen. Der erste Teil des Moduls behandelt somit grundlegende Aspekte der Festigkeitslehre, sowie der Rheologie. Im zweiten Teil

des Moduls wird auf die Chemie unterschiedlicher Bauwerkstoffe (z.B. Ziegelsteine, Zement, Beton oder Asphalt) eingegangen und deren mechanische und rheologische Eigenschaften werden auf der Grundlage der atomaren Struktur und der kolloidalen Wechselwirkungen der Materialien dargestellt.

Das Modul behandelt zusammenfassend folgende Fragen:
• Welche Werkstoffklassen sind relevant als Bauwerkstoffe?
• Was sind die grundlegenden (mechanischen) Eigenschaften von Werkstoffen und wie leiten sie sich aus der atomaren Struktur ab?
• Wie werden mechanische Materialeigenschaften gemessen?
• Welche rheologischen Eigenschaften haben Bauwerkstoffe und wie kann man diese messen?
• Was sind die strukturellen Ursachen für die rheologischen Eigenschaften der behandelten Werkstoffe?
• Wie kann die (nanoskopische) Struktur der Werkstoffe beschrieben werden?
• Welche chemische Zusammensetzung haben die behandelten Werkstoffe: Beton, Asphalt, gebrannte Ziegelsteine, Kalksandstein sowie Porenbeton und wie werden diese technisch hergestellt und angewendet?
• Was sind aktuelle technische Herausforderungen und Forschungsfragen im Bereich der großskaligen Strukturmaterialien?

Intended Learning Outcomes:
Nach erfolgreicher Teilnahme am Modul kennen die Studierenden die wichtigsten Werkstoffklassen im Bereich der Bauwerkstoffe und sind in der Lage, deren Struktur-Eigenschaftsbeziehung auf der Grundlage der atomaren Struktur zu diskutieren. Die Kenntnisse umfassen dabei sowohl das mechanische Verhalten der Werkstoffe (d.h. Festigkeit, Steifigkeit, etc.) als auch das rheologische Verhalten (d.h. Viskosität, Fließgrenze, etc.). Weiterhin können die Studierenden die chemische Struktur der wichtigsten Bauwerkstoffe (siehe oben) auf unterschiedlichen Größenskalen beschreiben. Insbesondere sind die Studierenden in der Lage, die technischen Eigenschaften der Materialien kritisch zu diskutieren und miteinander zu vergleichen. Abschließend haben die Studierenden ein fundiertes Verständnis auch für die aktuellen technischen Limitierungen der Werkstoffklassen und können daraus Fragestellungen an zukünftige Forschungsprojekte ableiten.

Teaching and Learning Methods:
Das Modul besteht aus einer Vorlesung (2 SWS) und einem Kurzpraktikum (1 SWS). Innerhalb der Vorlesung werden z.B. die Inhalte durch Vortrag des Dozierenden thematisiert. Dabei unterstützen Tafelanschriften und Folien-Präsentationen die Darstellung des Lehrstoffs und tragen somit zum Verständnis der Vorlesungsinhalte bei. Durch den Vortrag des Dozierenden ist ein stufenweiser Aufbau der Modulinhalte möglich. Die Vermittlung der Inhalte kann dem Lerntempo der Studierenden angepasst werden. Durch Fragen des Dozierenden an die Zuhörerschaft soll das Wissen gefestigt werden. Das Kurzpraktikum findet im Anschluss an die Vorlesung statt. Im praktischen Teil werden einfache keramische Werkstoffe (z.B. als Mörtel) hergestellt und deren rheologische (am Rotationsrheometer sowie durch Fließmaßbestimmung) und mechanische Eigenschaften (durch zerstörungsfreie Prüfmethoden wie Ultraschall und eine klassische Festigkeitsprüfung) charakterisiert.

Media:
Tafelarbeit, Folien, PowerPoint, Laborarbeit

Reading List:
W. Callister u. a., Materialwissenschaften und Werkstofftechnik: Eine Einführung, VCH, 2012
P. Coussot, Rheophysics - Matter in all its States, Springer, 2014
G. Neroth u.a., Wendehorst Baustoffkunde, Springer, 2011

Responsible for Module:
Gädt, Torben; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Bauchemie 1 (CH3153b/NAT0183) (Praktikum, 1 SWS)
Gädt T

Bauchemie 1 (CH3153a/NAT0183) (Vorlesung, 2 SWS)
Gädt T
For further information in this module, please click campus.tum.de or here.

Module Description

CH3154: Nano Materials | Nanomaterialien

Version of module description: Gültig ab summerterm 2021

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

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

Description of Examination Method:
Die Prüfungsleistung wird in Form einer Klausur (90 Minuten) erbracht. Dabei zeigen die Studierenden, dass sie die unterschiedlichen Domänen der Nanomaterialien kennen und die physikalisch-chemischen Grundlagen dazu beherrschen. Die unterschiedlichen Techniken zur Herstellung von Nanomaterialien werden schriftlich wiedergegeben. Des Weiteren sollen die Studierenden mögliche Potentiale von Nanomaterialien analysieren und die Grundlagen dazu aufgreifen. Die Prüfungsfragen umfassen den gesamten Modulstoff.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fortgeschrittene Kenntnisse und Interesse an Nanomaterialien, der anorganischen Chemie, Polymerchemie und Kolloidchemie.

Content:
Nanomaterialien kommen in allen Domänen des Alltags vor: In biologischen und geologischen Systemen, als gezielt hergestellte Komponente moderner Materialien, sowie als Nebenprodukt menschlicher und natürlicher Prozesse. Das Modul bietet eine Einführung in folgende Themen:

- Die verschiedenen Klassen von Nanomaterialien
- Physiko-chemische Eigenschaften von Nanomaterialien
- Die Herstellung von anorganischen und organischen Nanomaterialien (verschiedene Top-Down Verfahren wie Lithographie und Bottom-Up Verfahren wie Selbstorganisation)
- Industrielle Anwendungen von chemisch hergestellten Nanomaterialien (u.a. Pigmente, Emulsionspolymere, CaCO3, Silica, Baumaterialien)
- Aktuelle Forschungstrends im Feld der Nanomaterialien

Der Schwerpunkt des Moduls liegt dabei auf chemisch-synthetischen Nanomaterialien (in der Regel Bottom-Up Verfahren), deren Herstellung, Eigenschaften und Anwendungen.

Intended Learning Outcomes:
Nach erfolgreicher Teilnahme am Modul sind die Studierenden in der Lage, die verschiedenen Klassen von Nanomaterialien zu erkennen. Die Studierenden haben einen Überblick über Methoden zur Herstellung von Nanomaterialien und sind in der Lage, die Vor- und Nachteile der Herstellungsprozesse einzuordnen.
Des Weiteren sind die Studierenden in der Lage, die unterschiedlichen Eigenschaften der Nanomaterialien (wie z.B. mechanische, elektronische, thermische, optische Eigenschaften) zu erkennen und mit der Struktur zu verknüpfen. Die gängigen Techniken zur Charakterisierung von Nanomaterialien sind bekannt und können kompetent von den Studierenden auf die unterschiedlichen Klassen angewendet werden.

Teaching and Learning Methods:
Das Modul besteht aus einer Vorlesung (2 SWS) und einer Übung/Praktikum (1 SWS). Innerhalb der Vorlesung werden z.B. die Inhalte durch Vortrag des Dozierenden thematisiert. Dabei unterstützen Tafelanschriften und Folien-Präsentationen die Darstellung des Lehrstoffs und tragen somit zum Verständnis der Vorlesungsinhalte bei. Durch den Vortrag des Dozierenden ist ein stufenweiser Aufbau der Modulinhalte (Grundlagen zu weiterführenden Inhalten) möglich. Die parallel zur Vorlesung stattfindende Übung soll das Verständnis der Modulinhalte ergänzen und zusätzlich fördern. In der Lernplattform Moodle werden die Unterlagen und die Übungen zur Verfügung gestellt.

Media:
PowerPoint, Tafelarbeit, Moodle

Reading List:
- Nanophysik und Nanotechnologie - eine Einführung in die Konzepte der Nanowissenschaft, E.L. Wolf, Wiley-VCH, 2015
- Concepts of Nanochemistry, L. Cademartiri, Wiley-VCH, 2009
- Nanochemistry - A chemical approach to nanomaterials, G. A. Ozin, RSC Publishing 2009

Responsible for Module:
Gädt, Torben; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Nanomaterialien (CH3154b/NAT0184) (Praktikum, 1 SWS)
Gädt T

Nanomaterialien (CH3154a/NAT0184) (Vorlesung, 2 SWS)
Gädt T
For further information in this module, please click campus.tum.de or here.

Specialization in Technology: Electrical Engineering and Information Technology (minor) | Technik-Schwerpunkt: Elektro-/ Informationstechnik Basismodule (minor)

Elective area 1 | Wahlbereich 1

Module Description

EI10002: Principles of Electrotechnology | Principles of Electrotechnology [PiET]

Version of module description: Gültig ab winterterm 2017/18

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:
This module will be assessed in a written final examination (90 min) after the teaching weeks. In this examination it is to verify that the candidates are able to understand the general principles of electrical engineering and to solve relevant problems in the fields covered in this module in a limited time and without any resources. The examination will cover all parts of the lectures and exercises.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge of electricity and magnetism on high school level.
Basic knowledge of vector analysis.

Content:
Electrostatics:
Electrical charges, Coulomb's law, electrostatic fields, electrostatic potentials and voltages.

Dielectric materials:
Polarisation, dielectric displacement vector, Gauß' law, capacitors and capacitances.

Stationary electrical currents:
Current densities, local and integral Ohm's law, Kirchhoff's laws, resistors and resistivities, electrical networks, voltage and current sources, equivalent circuits, electrical energy and power.

(Electro-)magnetism:
Fundamental terms in magnetism, magnetic dipoles, Dia-, Para-, Ferromagnetism, magnetising field, magnetic induction, Amperé's law, electromagnetic induction, Faraday's law, inductors and inductivities, transformers.

Intended Learning Outcomes:
After participating in the modules lectures and exercises, students are able to understand and apply the basic physical principles of electrical engineering. They have acquired basic knowledge and understanding of some of the underlying problem-solving methods of electrical engineering.

Teaching and Learning Methods:
Teaching methods in lectures and exercises: Lecture-style instructions mainly on the blackboard. In solving relevant exercises a deeper knowledge of the subject-matters presented in the lectures is sought.

Media:
The following media types are used in the lectures and exercises:
- Explanations and exemplifications on the black board, partly supplemented by computer-aided presentations.
- Downloads on the Internet.
- Exercises are provided with the objective that the students first should solve the problems independent by themselves, solution to the problems will be demonstrated in subsequent exercise sessions, and subsequently will be made available also via download on the Internet.

Reading List:
References will be presented in the first lecture hour.

Responsible for Module:
Schrag, Gabriele; Prof. Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Principles in Electrotechnology (Vorlesung, 3 SWS)
Wittmann F (Essing S)

Principles in Electrotechnology (Übung, 1 SWS)
Wittmann F [L], Essing S (Schrag G)
For further information in this module, please click campus.tum.de or here.

Module Description

EI1289: Electrical Engineering | Elektrotechnik

Version of module description: Gültig ab summerterm 2019

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

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

Description of Examination Method:
Die Prüfungsleistung wird in Form einer Klausur (90 min) erbracht. In dieser soll nachgewiesen werden, dass in begrenzter Zeit mit Hilfsmittel (2 handgeschriebene A4-Seiten) in den Veranstaltungen des Moduls behandelte Grundaufgaben gelöst werden können. Die Klausur besteht aus Fragen, in dem das Verständnis geprüft wird, und Aufgaben, in den z.B. eine Kurzschlussberechnung eines Transformators berechnet werden müssen. Mit den Prüfungsaufgaben wird das Erreichen der angestrebten Lernergebnisse des Moduls geprüft. Die Prüfungsfragen gehen über den gesamten Vorlesungsstoff.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse der elektrischen Energietechnik;

Content:
Elektrische Größen und Grundgesetze
Elektromagnetismus
Analogien des elektrischen und magnetischen Feldes
Wechselstromkreise
Drehstromsystem
Elektrische Maschinen
Grundlagen Leistungselektronik
Elektronische Bauelemente
Steuerungstechnik

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung ist der Studierende in der Lage, die Grundzüge der Elektrotechnik zu verstehen. Er kennt die Grundlagen der elektrischen und magnetischen Felder, ist vertraut mit Gleichstrom-, Wechselstrom- und Drehstromsystemen. Die Funktion und Beschreibung von elektrischen Maschinen wird grundsätzlich anhand von Beispielen erklärt. Die Grundlagen der Leistungselektronik sowie die wesentlichen Bauelemente wurden ihm vorgestellt.

Teaching and Learning Methods:
Das Modul besteht aus einer Vorlesung (2SWS) und einer Übung (1SWS). In der Vorlesung wird der Lernstoff mittels PowerPoint-Präsentation vermittelt. Details und Beispiele werden an der Tafel präsentiert. In der Übung werden konkrete Aufgabe und Beispiele an der Tafel vorgerechnet.
Als Lernmethode wird zusätzlich zu den individuellen Methoden des Studierenden eine vertiefende Wissensbildung durch mehrmaliges Aufgabenrechnen in Übungen angestrebt.

Als Lehrmethode wird in der Vorlesungen und Übungen Frontalunterricht gehalten, in den Übungen auch Arbeitsunterricht (Aufgaben rechnen).

Media:
Folgende Medienformen finden Verwendung: Folienvortrag, Skriptum,Übungen, Laborführungen

Reading List:
" Elektrotechnik, Energietechnik
Elpers, Meyer, Skornitzke, Willner
Kieser Verlag, ISBN 3-8242-2022-9
" Taschenbuch der Elektrotechnik
Kories, Schmidt-Walter
Verlag Harry Deutsch, ISBN 3-8171-1563-6
" Fachkunde Elektrotechnik
Verlag Europa-Lehrmittel, ISBN 3-8085-3020-0
" Einführung in die Elektrotechnik
Jötten, Zürneck
Uni-Text, Vieweg Verlag
" Grundlagen der Elektrotechnik
Phillipow,
Hüthig Verlag
" Theoretische Elektrotechnik
Simonyi,
Deutscher Verlag der Wissenschaften

"

Responsible for Module:
Witzmann, Rolf; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Elektrotechnik (LB-MT; DBP-MT; TUM BWL) (Vorlesung mit integrierten Übungen, 3 SWS)
Almomani T [L], Dominguez Librandi M, Witzmann R
For further information in this module, please click campus.tum.de or here.

Elective area 2 | Wahlbereich 2

Module Description

EI00120: Digital Design | Digitaltechnik

Version of module description: Gültig ab winterterm 2018/19

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

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

Description of Examination Method:
In a written final exam (60 min), students will demonstrate both their basic understanding of the lecture and exercise content, as well as their ability to apply the learned content to practical problems in digital circuit design. This includes among others, the application of the Boolean logic to the functionally equivalent transformation and logic minimization of logical equations and truth tables, the realization of arbitrary combinatorial logic expressions as transistor circuits and two-stage canonical logics, the timing analysis of sequential circuits and finite state machines (FSMs) at the register transfer level.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
none

Content:
Fundamentals of digital information representation, processing and storage: basic model for functional behavior of MOSFET transistors, current equations, delay time and dynamic power loss. Circuit-technical realization of arithmetic operations (addition, subtraction, multiplication) as well as the synthesis of two- and multi-stage combinatorial operations (conjunction, disjunction, negation) and sequential switching operations from elementary basic components (logic gates, registers, MOSFET transistors). Logic optimization of combinatorial switching networks. Techniques for improving the information throughput of clocked, sequential switching devices by means of assembly line and parallel processing. Role and design of finite state machines as control units of various practical applications. Fundamentals of the methodical testing of circuits: fault diagnosis,

derivation of error coverage tables, determination of the test in combinatory switching networks and sequential switching mechanisms.

Intended Learning Outcomes:
After completing the module, students will be able to understand basic circuit concepts of digital logic and function blocks, to analyze their interaction, to evaluate functionality and to develop simple blocks themselves. Performance-optimized implementations of multistage combinatorial logic blocks as well as finite state machines (FSMs) can be derived, evaluated and developed using the design principles of pipeline and parallel processing. Furthermore, the students acquire a basic understanding of the operation of MOS transistors and their application in CMOS circuits.

Teaching and Learning Methods:
In the lectures, the technical content will be introduced by means of a lecture and a PowerPoint presentation and will be illustrated immediately by means of smaller calculation examples or derivations, which are manually introduced into the PowerPoint slides. This material is made available to students through Moodle. In addition, students are actively encouraged to ask questions, which is also being enthusiastically received. Central exercises and tutorial exercises are also carried out with tablet and table address and also deepen the lecture contents by calculating tasks as well as supported solving of exercises.

Media:
The following media forms are used:
- Tablet text
- Presentations
- Script
- Handwritten lecture material and exercises with solutions as download on the Internet

Reading List:
Optional literature recommendations:
- H. Lipp, J. Becker, "Grundlagen der Digitaltechnik", Oldenbourg, 2008
- J. Rabaey, "Digital Integrated Circuits - A Design Perspective", Prentice Hall, 2003
- U. Tietze, Ch. Schenk, "Halbleiter-Schaltungstechnik", Springer, 2002
- J. Wakerly, "Digital Design Principles and Practices", Prentice Hall, 2006

Responsible for Module:
Herkersdorf, Andreas; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Digitaltechnik (Vorlesung mit integrierten Übungen, 5 SWS)
Herkersdorf A, Maurer F, Biersack F, Stechele W, Wild T

Digitaltechnik - Tutorübungen (Tutorium, ,1 SWS)
Maurer F [L], Herkersdorf A
For further information in this module, please click campus.tum.de or here.

Module Description

EI10003: Analog Electronics | Analog Electronics [AE]

Version of module description: Gültig ab summerterm 2018

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

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

Description of Examination Method:
This module will be assessed in a written final examination (90 min) after the teaching weeks. In this examination it is to verify that the candidates are able to understand the general principles of analog electronic circuits and to solve simple but relevant problems in the fields covered in this module in a limited time and without any resources. The examination will cover all parts of the lectures and exercises of this module.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Subject matters as presented in the module "Principle of Electrotechnology"
Calculus; complex numbers and operations for ac signal analysis

Content:
Electronic signals
Circuit analysis (dc, ac)
Electrical characteristics of electronic devices
Electronic filters
Basics of semiconductor’s physics
PN Junctions, pn diodes
Transistors
Basic Transistor circuits
Amplifiers

Intended Learning Outcomes:
After participating in the modules lectures and excercises, students are able to
- understand and apply the basic principles of analog electronic cicuits

- have acquired basic knowledge and understanding of some of the basic problem-solving methods of electronic cicuits.

Teaching and Learning Methods:
Teaching methods in the lectures and excercises: frontal teaching with presentations and on the blackboard.
In solving relevant exercises a deeper knowledge of the subject matters of the lessons is sought.

Media:
The following media types are used in the lectures and excercises:
- Presentations (also for downloads on the Internet)
- Explanations and exemplifications on the black board
- Exercises are provided with the objective that the students first should solve the problems independent by themselves, the solutions to the problems will be demonstrated in subsequent excercise sessions, and subsequently will be made available also via download on the Internet.

Reading List:

Responsible for Module:
Schrag, Gabriele; Prof. Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Analog Electronics (Vorlesung, 2 SWS)
Schrag G, Seidl M

Analog Electronics (Exercises) (Übung, 1 SWS)
Schrag G, Seidl M
For further information in this module, please click campus.tum.de or here.

Specialization in Technology: Information Technology and Electronics (major) | Technik-Schwerpunkt: Informationstechnik und Elektronik Vertiefungsmodule (major)

Module Description

EI0631: Media Technology | Medientechnik

Version of module description: Gültig ab winterterm 2015/16

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

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

Description of Examination Method:
The type of examination is a written exam with 90 minutes duration. Students solve selected problems based on the introduced concepts and equations. Additionally, they answer questions about the lecture content and explain in their own words selected methods from the lecture. Students are allowed to bring 4 pages of handwritten notes and a non-programmable calculator. Matlab assignments with voluntary participation are offered during the semester and can be used to improve the final grade of the course.

The final grade is composed of the following elements:
- 100% final exam

Successful completion of the Matlab assignments leads to a bonus of 0.3 on the final grade in case the final is passed. The Matlab assignments are successfully completed if at least an average of 65% is obtained when submitting the solutions to the module tutor.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Higher Mathematics, Linear Algebra, Signal Processing

Following modules should have been accomplished before participation:
- Signals
- Introduction to signal processing

- Systems

Content:
image construction camera models and coordinates, mapping from world to pixel coordinates, camera calibration, sterea camera systems, image synthesis,the rasterization of geometric primitives, geometric scene description using polygon meshes and parametric surfaces, illumination of surfaces, shading, texture mapping, rendering pipeline, analog video, color TV systems, digital video, format conversion

Intended Learning Outcomes:
Upon completion of the module, students are able to:
- characterize the fundamental principles of information retrieval using the example of text and image search and to evaluate the performance of different approaches
- develop a simple system for media search and to evaluate its performance
- describe the creation of images and mathematically compute the mapping between world coordinates and pixel coordinates for single and stereo camera systems
- perform external and internal camera calibration and analyze the calibration error
- describe the fundamental principles of image synthesis including the rasterization of geometric primitives, geometric scene description using polygon meshes and parametric surfaces, illumination of surfaces, shading, texture mapping
- describe the basic steps of the rendering pipeline and evaluate it for simple scenes with point light sources
- characterize analog and digital video and to analyze their differences
- compute the influence of phase errors for color TV systems NTSC, SECAM, and PAL.
- perform the conversion between different formats for digital TV signals

Teaching and Learning Methods:
Teaching and learning methods consist of presentations during the lecture and the exercises. Moreover, the students will improve their knowledge by use of scientific literature and implement selected concepts of the lecture using matlab during the voluntary project during the semester.

Media:
Following forms of media are applied:
- presentations
- script
- exercises with solution (downloadable from the internet)

Reading List:
Following literature is recommended:
- R. Steinmetz, Multimedia-Technology Springer-Verlag, 3. überarb. Auflage, 2000.
- Foley et al, Computer Graphics: Principles and Practice, Addison Wesley, zweite Auflage, 1995.
- Manning et al., Introduction to Information Retrieval, Cambridge University Press, 2008.
- U. Schmidt, Professionelle Videotechnik, Springer-Verlag, 2000.

Responsible for Module:
Steinbach, Eckehard; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Medientechnik (Vorlesung mit integrierten Übungen, 4 SWS)
Steinbach E, Xu X
For further information in this module, please click campus.tum.de or here.

Module Description

EI73871: Technical Acoustics and Noise Abatement | Technische Akustik und Lärmbekämpfung

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**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:
During the 90-min written exam, students will be asked to demonstrate a fundamental knowledge and understanding of the lecture content in technical acoustics. The exam contains multiple questions including: 1) multiple-choice type, 2) calculations of practically-relevant problems in technical acoustics and of problems in general (theoretical) acoustics. The questions examine the understanding of fundamental concepts in acoustics and the ability to design noise abatement measures and include the reproduction of learned knowledge. A collection of basic formulas will be provided for the exam.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of calculus for engineers (e.g. logarithm, differential calculus) required, basics of sound propagation from lecture Audio Communication (B.Sc.) recommended.

Content:
Introduction: acoustics and noise control, principles of noise reduction, sound fields, level calculation.
Origin and propagation of sound: simple oscillators, resonators, types of sound waves.
Point sources, geometrical acoustics, absorption, room acoustics: room modes, statistical room acoustics, reverberation time, simulation methods, psychoacoustics of rooms.
Airborne sound insulation, body-borne sound insulation.
Sound measurement technology and sound impact: Measurement microphones, weighted sound level (A, C, D), time constants (I, F, S), equivalent sound pressure level Leq, sound analysis with absolute and relative constant bandwidth, sound of rotating machinery, third-octave band analysis,

insertion loss. Calculation procedures: loudness level, loudness, psychoacoustic annoyance, Speech Interference level (SIL), Temporary and Permanent Threshold Shifts (TTS & PTS). Noise control according to (European) law, codes and norms: noise at workplaces, noise from machines, industrial noise (“TA Lärm”), noise from road traffic, railroads and aircrafts. Practical introduction to acoustic measurements: applicable norms, use of measurement equipment, conduction of measurements in the anechoic chamber, analysis of measurements, creation of measurement reports.

Intended Learning Outcomes:
Upon successful completion of the module students will be able to apply their understanding of fundamental aspects in acoustics to basic problems of noise control and noise reduction, to analyze them and to propose solutions. Therefore, students will be able to independently conduct simple acoustical measurements and to calculate and asses sound propagation and effects of sound insulation. Furthermore, students can assess and evaluate means of technical acoustics on the basis of important codes and norms, measurement instructions, as well as legal limits.

Teaching and Learning Methods:
Lecture with many practical demonstrations, exercise session on how to calculate sound propagation of different sound sources (distance and direction-based characteristics), sound propagation in rooms, and the effects of sound insulation methods and resonators; conduct individual, guided acoustical measurements in the anechoic chamber; self-study of acoustic fundamentals, norms and mathematical methods and multimedia content (e.g. video tutorials).

Media:
Lecture with comprehensive (audio) demonstrations, projection of written content, written compilation of content and formulas (Moodle), (multimedia) presentation of practical examples and additional information in class, separate exercise session on calculating and solving practical problems; hands-on introduction to acoustical measurements in the institute’s anechoic chamber.

Reading List:
M. Möser: Technische Akustik, 10. Aufl. Springer, 2015.
G. Müller, M. Möser (Hrsg.): Taschenbuch der Technischen Akustik, 3. Auflage, Springer, 2004.

Responsible for Module:
Seeber, Bernhard; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
2 SWS VO, 2 SWS UE
Prof. Dr.-Ing. Bernhard Seeber
For further information in this module, please click campus.tum.de or here.

Specialization in Technology: Power Engineering (major) | Technik-Schwerpunkt: Energietechnik Vertiefungsmodule (major)

Module Description

EI0610: Electrical Drives - Fundamentals and Applications | Elektrische Antriebe - Grundlagen und Anwendungen

Version of module description: Gültig ab winterterm 2016/17

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

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

Description of Examination Method:
In einer schriftlichen Abschlussklausur (90 min) ohne Hilfsmittel weisen die Studierenden durch das Beantworten von Wissensfragen und Rechnungen, dass sie die Aufbau und Einbettung von Antrieben in übergeordnete Systeme verstanden haben. Daneben weisen sie die Fähigkeit beispielsweise zur korrekten Berechnung von Parametern wie Auslegung und Diemensonierung nach.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Differentialgleichungen, komplexe Wechselstromrechnung, Maxwell-Gleichungen, Lorentz-Kraft, Regelungstechnik

Folgende Module sollten vor der Teilnahme bereits erfolgreich absolviert sein:
- Mathematik 1 bis 4
- Elektrizität und Magnetismus
- Systeme

Content:
Geregelte elektrische Antriebe: Grundsätzliche Struktur, Verhalten im anzutreibenden System, Komponenten und deren Eigenschaften (elektrische Maschine, Stromrichter und deren Steuerung bzw. Regelung), Zusammenwirken der Komponenten, Auswirkung von digitalen Reglern, Normen und Richtlinien (CE-Kennzeichnung)

Intended Learning Outcomes:
Nach dem erfolgreichen Abschluss des Moduls kennt der Studierende den grundsätzlichen Aufbau sowie das Verhalten von geregelten Antrieben und ist in der Lage, die Wechselwirkungen zwischen ihren Bestandteilen sowie mit übergeordneten Systemen zu erkennen, einzuschätzen und zu berechnen. Er hat die Fähigkeit, elektrische Antriebe sowie deren Komponenten in realen Anwendungen grob auszulegen. Der Studierende hat vertiefte Kenntnis und Verständnis der elektromagnetischen Drehmomenterzeugung und Spanungsinduktion, und Verständnis der Hintergründe und Ziele der CE-Kennzeichnung sowie deren Konsequenzen für geregelte elektrische Antriebe.

Teaching and Learning Methods:
AIn den Vorlesungen wird Frontalunterricht gehalten. In den Übungen erfolgt die selbsständige Befassug der Studierenden mit den Themen des Moduls zum Kompetenzerwerb (Aufgaben rechnen, vertiefende Herleitungen und Simulationsbeispiele).

Media:
Folgende Medienformen finden Verwendung:
- Präsentationen (Overhead und PowerPoint)
- Skript
- Übungsaufgaben und Lösungsfolien als Download im Internet

Reading List:
Folgende Literatur wird empfohlen:
- Schröder, D. "Elektrische Antriebe-Grundlagen", 3. Auflage 2007, Springer Verlag, Hamburg
- Brosch, F. "Moderne Stromrichterantriebe", 4. Auflage, 2002, Vogel Verlag und Druck
- Mohan, N. Electric Drives: An integrative approach , MNPERE, Minneapolis, USA, 2001
- Groß, H. et al. "Elektrische Vorschubantriebe in der Automatisierungstechnik", 1. Auflage, Publicis Corporate Publishing, 2000

Responsible for Module:
Lobo Heldwein, Marcelo; Prof. Dr.sc. ETH Zürich

Courses (Type of course, Weekly hours per semester), Instructor:
Elektrische Antriebe - Grundlagen und Anwendungen (Vorlesung mit integrierten Übungen, 3 SWS)
Cordier J (Ebert W), Osterhammer M, Klaß S
For further information in this module, please click campus.tum.de or here.

Module Description

EI7328: Electromagnetic Compatibility in the Field of Power Engineering | Elektromagnetische Verträglichkeit in der Energietechnik

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
In einer Klausur (60 min) ohne Hilfsmittel weisen Studierende durch die Beantwortung von Fragen nach, dass sie die wesentlichen Kentnisse zur Umsetzung von EMV-gerechten Geräten und Analgen besitzen und geeignete Maßnahmen zur Blitzschutztechnik für vorgegebene Anwendungsfälle wiedergeben können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Keine speziellen Voraussetzungen erforderlich.

Content:
Einführung, Grundbegriffe und Definitionen. Beispiele für Störquellen. Koppelmechanismen, passive Schutz- und Entstörungskomponenten (Filter, Ableiter, Schirme). Maßnahmen zur EMV-gerechten Gestaltung von Geräten und Anlagen. Elektromagnetische Beeinflussung durch Blitzentladungen; Blitzschutztechnik. Spezielle EMV-Probleme in der Energie- und Automatisierungstechnik. Wirkung elektromagnetischer Felder auf Bioorganismen.

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung ist der Studierende in der Lage, die mögliche Wirkung von Störquellen und die Koppelmechanismen zu verstehen und diese Kenntnisse in geeignete Maßnahmen zur EMV-gerechten Gestaltung von Geräten und Anlagen umzusetzen. Weiter versteht er die Mechanismen, die zur Blitzentladung und infolge zu verschiedenen Schädigungen führen und ist in der Lage, geeignete Maßnahmen zur Blitzschutztechnik umzusetzen.

Teaching and Learning Methods:
Als Lernmethode wird zusätzlich zu den individuellen Methoden des Studierenden eine vertiefende Wissensbildung durch Aufgabenrechnen in Übungen angestrebt.

Als Lehrmethode wird in der Vorlesungen Frontalunterricht, in den Übungen Arbeitsunterricht (Aufgaben rechnen) gehalten. Im Rahmen von Begehungen werden ergänzende Erläuterungen im Hochspannungslabor gegeben.

Media:
Folgende Medienformen finden Verwendung:
- Präsentationen
- Rechnerische und experimentelle Übungen

Reading List:
Folgende Literatur wird empfohlen:
- Schwab, A.J.: Elektromagnetische Verträglichkeit. Springer Verlag, 5. Auflage, 2007
- Heidler, F; Stimper, K.: Blitz und Blitzschutz. VDE-Schriftenreihe - Normen verständlich Band 128. VDE-Verlag Berlin.

Responsible for Module:
Koch, Myriam; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Elektromagnetische Verträglichkeit in der Energietechnik (Vorlesung mit integrierten Übungen, 4 SWS)
Hinterholzer T
For further information in this module, please click campus.tum.de or here.

Specialization in Technology: Computer Engineering (minor) | Technik-Schwerpunkt: Computer Engineering Basismodule (minor)

Module Description

IN0003: Functional Programming and Verification | Funktionale Programmierung und Verifikation

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
The exam takes the form of a 120 minutes written test. Small programming tasks allow to assess whether the students master a functional programming language and are able to realize small implementation problems. By inferring simple invariants they demonstrate that they have understood the principles of program verification and are able to apply these.
The successful completion of homework asignments may contribute to the grade as a bonus. The exact details for this are announced timely at the begin of the lecture.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
IN0001 Introduction to Informatics

Content:
Among others, the module IN0003 is concerned with the following topics:
- Correctness of imperative programs
++ Verification according to Floyd or Hoare
++ Termination
++ Procedures
- Basic concepts of functional programming
++ Values, variables, functions
++ Data++structures, pattern matching
++ Higher order functions

++ Polymorphic types
++ Programming in the large: Structures and Functors
++ Correctness of functional programs
+++ Semantics of functional programs
+++ Verification of functional programs

Intended Learning Outcomes:
After successful completion of the module, participants understand the key concepts of functional programming languages. They are able to solve well presented tasks in a functional programming language. Therefore, they are able to acquire programming skills on their own also in further functional programming languages. They also are familiar with the most important techniques for the verification of imperative and functional programming language and can apply them to simple programs.

Teaching and Learning Methods:
By means of a presentation, either by slides or whiteboard, the lecture transports the concepts of verification and the programming language and illustrates them by examples.
Accompanying assignments for individual study deepen the understanding of the concepts explained in the lecture, and train students to apply these to the verification of small programs and to master programming in the given programming language.

Media:
Slide show, blackboard, possibly online programming and/or animations

Reading List:
Guy Cousineau und Michel Mauny, The Functional Approach to Programming, Cambridge University Press, Cambridge, 1998
Apt, Olderog: Programm-Verifikation. Springer 1991
Gerd Smolka: Programmierung - eine Einführung in die Informatik mit Standard ML. Oldenburg, 2007
Simon Tompson: Haskell: the Craft of Functional Programming. Addison-Wesley, 2011

Responsible for Module:
Seidl, Helmut; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Funktionale Programmierung und Verifikation (IN0003) (Vorlesung, 2 SWS)
Seidl H [L], Erhard J, Schwarz M, Seidl H

Übungen zu Funktionale Programmierung und Verifikation (IN0003) (Übung, 2 SWS)
Seidl H [L], Erhard J, Schwarz M, Seidl H
For further information in this module, please click campus.tum.de or here.

Module Description

IN2339: Data Analysis and Visualization in R | Data Analysis and Visualization in R

Version of module description: Gültig ab winterterm 2016/17

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 90	**Contact Hours:** 90

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

Description of Examination Method:
Written exam and project work:
The listed achievements, see Intended Learning Outcomes, are evaluated by one written exam of 90 min. There will be moreover two case studies, where the students must provide the source code that generates the report of an analysis of a given dataset. The analysis of this data covers all topics stated under Intended Learning Outcomes. The first case study covers topics 1-7. The second covers the topics 8-16. The final mark is the exam mark with bonus points for the two case studies.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
R programming basics 1
R programming basics 2 (including report generation with R markdown)
Data importing
Cleaning and organizing data: Tidy data 1
Cleaning and organizing data: Tidy data 2
Base plot
Grammar of graphics 1
Grammar of graphics 2
Unsupervised learning (hierarchical clustering, k-means, PCA)
Case study I
Drawing robust interpretations 1: empirical testing by sampling

Drawing robust interpretations 2: classical statistical tests
Supervised learning 1: regression, cross-validation
Supervised learning 2: classification, ROC curve, precision, recall
Case study II

Intended Learning Outcomes:
At the end of the module students are able to:
- 1. produce scripts that automatically generate data analysis report
- 2. import data from various sources into R
- 3. apply the concepts of tidy data to clean and organize a dataset
- 4. decide which plot is appropriate for a given question about the data
- 5. generate such plots
- 6. know the methods of hierarchical clustering, k-means, PCA
- 7. apply the above methods and interpret their outcome on real-life datasets
- 8. know the concept of statistical testing
- 9. devise and implement resampling procedures to assess statistical significance
- 10. know the conditions of applications and how to perform in R the following statistical tests: Fisher test, Wilcoxon test, T-test.
- 11. know the concept of regression and classification
- 12 apply regression and classification algorithms in R
- 13. know the concept of error in generalization, cross-validation
- 14. implement in R a cross-validation scheme.
- 15. know the concepts of sensitivity, specificity, ROC curves
- 16. assess the latter in R

Teaching and Learning Methods:
Lecture provides the concept + programming exercises where these concepts are applied on data. The goal of each exercise is the generation of report documents.

Media:
Weekly posted exercises online, slides, live demo

Reading List:
An Introduction to Statistical Learning
with Applications in R http://www-bcf.usc.edu/~gareth/ISL/
R for Data Science, by Garrett Grolemund and Hadley Wickham

Responsible for Module:
Gagneur, Julien; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Data Analysis and Visualization in R (IN2339) (Vorlesung, 2 SWS)
Gagneur J [L], Gagneur J

Exercise Data Analysis and Visualization in R (IN2339) (Übung, 4 SWS)
Gagneur J [L], Gagneur J
For further information in this module, please click campus.tum.de or here.

Specialization in Technology: Computer Engineering (major) | Technik-Schwerpunkt: Computer Engineering Vertiefungsmodule (major)

Module Description

ED180013: Energy Informatics | Energie Informatik

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
The module examination is a written test of 120 min (no auxiliary tools except a calculator are allowed).
It consists of short questions on power system, electric markets, smart grid concepts and components as well as on computer science techniques in energy systems. Calculatory question test the ability of students to model and assess power systems, integration concepts of renewable energies and flexible loads.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
Today's electric power grids are cyber-physical systems, where information technology plays an important role in reliably operating all system components. Many countries have set ambitious renewable resource integration targets. Achieving these targets requires fundamental changes to the management of the electric power grid since the output of many renewable sources, such as wind and solar, is highly variable: it cannot be controlled on demand, exhibits large fluctuations, and is uncertain. Thus, instead of scheduling power supply to satisfy demand, a growing fraction of the demand will have to be managed to match variable renewable generation. In addition to traditional large scale energy storage, distributed flexible loads and storage on the distribution level, for instance in heat, ventilation, and air conditioning (HVAC) systems, heat pumps, plug-in electric vehicles (PEVs), and innovative chemical energy storage will be leveraged to dynamically

align electricity consumption with variable generation. Efforts to coordinate large populations of these kinds of distributed energy storage using information technology are often subsumed under the term Smart Grid. Building Smart Grids requires a deep understanding of the technical and operational characteristics of electric power systems, finding efficient solutions to new optimization problems, developing appropriate data collection and storage methods, and being able to evaluate corresponding systems using model- and data-driven simulations. In this course, we will lay the foundations for students to understand where and how information technology and corresponding computational techniques apply in this area.

Intended Learning Outcomes:
After successfully completing the module "Energy Informatics" students are able to:
- Understand where & how computer science techniques apply in building a sustainable energy future.
- Understand power systems basics to be able to apply computer systems in energy management and in designing a smart power grid.
- Understand purpose & current operation of electricity markets to be able to further develop them.
- Understand smart grid concepts & components (e.g., advanced metering infrastructure, smart meters, demand response, load shifting, etc.).
- Understand properties of variable, non-dispatchable renewables (e.g., wind and solar) and their impact on power systems management.
- Understand properties of energy storage.
- Understand the possible future role of flexible loads such as heating, ventilation and air conditioning (HVAC) and plug-in electric vehicles (PEVs).
- Be able to model power systems using state-of-the-art software tools.
- Be able to assess integration concepts for renewable resources, energy storage, and flexible loads.

Teaching and Learning Methods:
The lectures take place as teacher centered teaching based on presentations in lectures. The material for the lectures is supplied in time online to the students. This is to understand where and how computer science techniques apply in building a sustainable energy future and to understand power systems basics to be able to apply computer systems in energy management and in designing a smart power grid.
During the exercises and homework including programming tasks, students learn with work sheets and discussions for example to model power systems using state-of-the-art software tools and to assess integration concepts for renewable resources, energy storage, and flexible loads.

Media:
- Presentations,
- Supplied Online material,
- Hands-on programming tasks,

Reading List:
- Alexandra von Meier: Electric Power Systems – A Conceptual Introduction. IEEE Press.

- Bruce F. Wollenberg: Power Generation, Operation, and Control. Wiley.
- Daniel Kirschen & Goran Strbac: Fundamentals of Power System Economics. Wiley.

Responsible for Module:
Goebel, Christoph; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Energy Informatics (Vorlesung mit integrierten Übungen, 4 SWS)
Goebel C (Lumpp S)
For further information in this module, please click campus.tum.de or here.

Module Description

IN2076: Advanced Computer Architecture | Advanced Computer Architecture

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
The exam takes the form of written 90 minutes exam. Questions allow to assess acquaintance with the concepts of Computer Architecture. Questions describing scenarios for the interaction of programs with certain architectures will assess the student's ability to evaluate architectural components and to apply the obtained knowledge.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
IN0004 Introduction to Computer Organization and Technology - Computer Architecture

Content:
After an introduction to the goals and the learning outcomes of the module, cross cutting aspects for all advanced architectures are presented. This section covers performance, availability, reliability, fault tolerance, parallelism, memory hierarchy and virtualization. After a recap of the computer architecture basics, the module covers the major types of parallelism and the respective architectures. For instruction level parallelism advanced concepts of the instruction pipeline are discussed as well as superscalar and VLIW processors. This part also covers advanced techniques for the memory hierarchy and compiler support for instruction level parallelism. The next architecture class, data parallel systems, covers vector units in standard processors, array computers, GPGPUs and vector supercomputers. The section presents also the programming interfaces and discusses their interaction with the architectures. Shared memory systems supporting thread level parallelism are discussed next. First the general concepts coherence, memory consistency and synchronization are covered. Then their implementation in uniform and non-uniform memory architectures is presented, ranging from standard multicore systems to large-scale shared memory systems. The last presented architecture class covers distributed

memory systems supporting process-level parallelism. This section presents high performance communication networks and design alternatives for network interfaces, manycore processors and massively parallel systems. Parallel file systems are discussed as they are important for all these systems. The module closes with optional presentations about energy efficiency, parallel applications, parallel programming, performance evaluation and non-conventional architectures.

Intended Learning Outcomes:
At the end of the module students know and understand the architecture of current processors as well as of entire IT systems. They can evaluate and assess different designs. The students understand the interaction of architecture and compiler technology. They understand the different classes of parallel architectures and can evaluate their advantages and disadvantages for certain applications.

Teaching and Learning Methods:
The module consists of a four hour lecture. The students need 90 hours to learn the presented concepts, and to understand and extend the presented examples. They need to come up with own examples to deepen their knowledge and should compare the learned concepts with presentations in the recommended text books.

Media:
Slides, mindmaps, script

Reading List:
- Hennessy, Patterson: Computer Architecture - A quantitative Approach.
- Andrew Tanenbaum: Structured Computer Organization
- David E. Culler et.al.: Parallel Computer Architecture: A Hardware / Software Approach
- Antonio Gonzales et.al.: Processor Microarchitecture: An Implementation Perspective

Responsible for Module:
Gerndt, Hans Michael; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Rechnerarchitektur (IN2076) (Vorlesung, 4 SWS)
Gerndt H [L], Gerndt H
For further information in this module, please click campus.tum.de or here.

Specialization in Technology: Industrial Engineering (minor) | Technik-Schwerpunkt: Industrial Engineering Basissmodule (minor)

Module Description

MGT001370: Designing Manufacturing Systems | Designing Manufacturing Systems

Version of module description: Gültig ab winterterm 2022/23

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 grade of the module is based on homework assignments during the semester and a written test, of 90 min, at the end of the semester.
The students demonstrate that they can create appropriate designs for different production systems using the approaches introduced in the lecture. Furthermore, students show that they are able to explain the fundamentals of the different design approaches and evaluate them. At the end of the lecture students will have a good understanding of the design of production systems and layouts, like job shops, flow lines, single flow rows, production centers, and flexible assembly layouts.
Allowed aids for the test will be announced at the beginning of the semester.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
PLEASE NOTE:
This module cannot be attended if WI100967 Designing and Scheduling Manufacturing Systems was attended previously.

Knowledge of quantitative approaches to production and supply chain management. The modules "Management Science” and “Production and Logistics” or similar modules at other universities are a prerequisite. Also, basic programming experience in Python is strongly recommended.

Content:
Decisions related to designing of a production system play an important role in all manufacturing industries. Decisions like configuration of a layout and planning of material flow are all essential for maximizing the profit of a company. In this course, the students learn how to support these decisions by applying various quantitative methods in application areas such as assembly systems, process industries, automotive industry and AGVs in flexible assembly layouts and production centers.
Content:
• Layout types
• Job shops
• Traditional assembly lines
• Flexible assembly lines
• Single flow row
• Center production

Intended Learning Outcomes:
After the module the students will be able to:
• Give an overview of methods used in designing production systems.
• Distinguish the most important production layout types (job shop, flow lines and production centers). Analyze the layout types advantages and disadvantages, decide for practical layout problems, which type to choose.
• Apply rough and exact planning approaches for the most important layout types, including the application of heuristics and the formulation and adaption of mathematical models.

Teaching and Learning Methods:
The module uses a blended learning approach with online on-demand lectures for the students to study on their own pace. Weekly in-class lectures are intended to re-cap the lecture material from the recorded videos, clarify questions and discuss extensions. The optional assignments involve the modelling of the design problems discussed in class and the implementation of these mathematical models.

Media:
Lecture slides, lecture video recordings and case studies, in-class exercises, homework assignments and their solutions.

Reading List:
Will be provided with course syllabus at the beginning of the semester.

Responsible for Module:
Grunow, Martin; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Designing Manufacturing Systems (MGT001370) (Limited places) (Vorlesung, 4 SWS)
Grunow M, Okumusoglu B, Schömig-Beißner M

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

Module Description

MGT001371: Scheduling Manufacturing Systems | Scheduling Manufacturing Systems

Version of module description: Gültig ab winterterm 2022/23

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 grade of the module is based on homework assignments during the semester and a written test, of 90 min, at the end of the semester.
The focus is on scheduling short term operations on the different manufacturing layout types. The students have to show that for different production systems they are able to apply suitable scheduling approaches taught in the lecture. Furthermore, the students demonstrate that they are able to explain the fundamentals of the different scheduling approaches and evaluate them.
Allowed aids for the test will be announced at the beginning of the semester.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
PLEASE NOTE:
This module cannot be attended if WI100967 Designing and Scheduling Manufacturing Systems was attended previously.

Knowledge of quantitative approaches to production and supply chain management. The modules "Management Science” and “Production and Logistics” or similar modules at other universities are a prerequisite. Also, basic programming experience in Python is strongly recommended.

Content:
Decisions related to scheduling of a production system play an important role in all manufacturing industries. Decisions like configuration of a layout and planning of material flow are all essential for maximizing the profit of a company. In this course, the students learn how to support these decisions by applying various quantitative methods in application areas such as assembly

systems, process industries, automotive industry and AGVs in flexible assembly layouts and production centers.
Content:
• Layout types
• Introduction to scheduling
• Job shops
• Flexible assembly systems
• Economic lot scheduling, block planning
• Scheduling AGV‘s in centers (online vs. offline scheduling)

Intended Learning Outcomes:
After the module the students will be able to:
• Give an overview of methods used in scheduling production systems.
• Give an overview of the scheduling objectives and requirements in manufacturing.
• Evaluate and apply different planning procedures (shifting bottleneck, scheduling of flexible assembly systems, economic lot scheduling, block planning and online vs. offline scheduling) to develop production schedules for different types of systems such as assembly lines, food processing systems and AGVs in flexible assembly layouts and production centers.
• Apply heuristics and formulate and solve mathematical models.

Teaching and Learning Methods:
The module uses a blended learning approach with online on-demand lectures for the students to study on their own pace. Weekly in-class lectures are intended to re-cap the lecture material from the recorded videos, clarify questions and discuss extensions. The optional assignments involve the modelling of the scheduling problems discussed in class and the implementation of these mathematical models.

Media:
Lecture slides, lecture video recordings and case studies, in-class exercises, homework assignments and their solutions.

Reading List:
Will be provided with course syllabus at the beginning of the semester.

Responsible for Module:
Grunow, Martin; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Scheduling Manufacturing Systems (MGT001371, englisch) (Vorlesung, 4 SWS)
Grunow M, Dörr J, Okumusoglu B, Schömig-Beißner M
For further information in this module, please click campus.tum.de or here.

Specialization in Technology: Sustainable Energies (minor) | Technik-Schwerpunkt: Sustainable Energies (minor)

Required Modules | Pflichtbereich

Module Description

EI70860: Integration of Renewable Energies | Integration of Renewable Energies [IRE]

Version of module description: Gültig ab summerterm 2020

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

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

Description of Examination Method:
The module exam consists of a written exam (60 min). The goal of the exam is to test with questions if the students are able to reproduce general challenges regarding the integration of renewable energies. With calculations on simple examples the capability of working with this general knowledge on specific questions is tested. The exam will be graded.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fundamental knowledge in:
- renewable energy technologies (hydro, wind, photovoltaic, biomass, geothermal)
- power generation and transportation in large quantities in future energy supply scenarios
- fossil and renewable energy carriers
- regulation frameworks in electricity markets
- political and social aspects in energy systems

Content:
The lecture is subdivided in an introduction and three main chapters (physical, system and market integration), which classify the different challenges of the integration of renewable energies in an existing electricity system:

The introduction discusses the characteristics of fluctuating power generation from renewable energies and derives the resulting challenges for the system.
Physical integration discusses (technical) options, which enable an adaption of the generation side and the demand side (grid, storage, demand side integration, etc.).
System integration evaluates the possible contribution of renewable energies to provide ancillary services (balancing power, reactive power, inertia, etc.).
Market integration explain the influence of an increasing share of renewables on the existing market participants and discusses alternative framework design options.

Intended Learning Outcomes:
Upon successful completion of the module, students are able to:
- describe the challenges of a power system with a high share of renewable energies
- understand the properties of renewable energies from a system perspective
- analyze possible options to improve the integration of the renewable energies
- understand the system behavior of renewable energies
- analyze the influence of renewable power generation on operation of the conventional power plant park
- assess renewable power generation in relation to electricity markets and the demand of balancing power

Teaching and Learning Methods:
Lecture: beamer and partly blackboard presentations with teacher centered teaching
Tutorials: Calculations (by hand or PC based) as well as reading assignments which are both discussed in lessons

Language of instruction, English in Winter Semester and German in Summer Semester.

Media:
Lecture and exercise with beamer and blackboard. Presentations and exercise will be presented online.

Reading List:
Lawrence E. Jones, Renewable Energy Integration, 2017
IEA: The Power of Transformation, 2014

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

Courses (Type of course, Weekly hours per semester), Instructor:
Integration of Renewable Energies (Vorlesung mit integrierten Übungen, 4 SWS)
Kuhn P, Gawlick J
For further information in this module, please click campus.tum.de or here.

Module Description

EI74831: Project Lab Renewable and Sustainable Energy Systems | Project Lab Renewable and Sustainable Energy Systems [PropENS]

Version of module description: Gültig ab winterterm 2018/19

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

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

Description of Examination Method:
Participants of the Project Lab Renewable and Sustainable Energy Systems should carry out analyses, planning and applications about renewable energy systems and their modelling.
A team of 3-5 students should achieve a goal defined for the group over the duration of the lecture period of the semester within the framework of the project work. The problem definition, role distribution, idea development as well as the choice of suitable instruments, implementation and documentation are to be developed essentially independently by the group. The essential aspects of the work within the framework of the project internship (e.g. essential scientific contents, the treatment of a task as a completed project, division of the task among the group members) should be documented in a written report (volume: 15-20 pages).
In a supplementary presentation, the competence of the students to present their work in a structured way in a small seminar in front of an audience consisting of staff members of the chair and students will be examined. Overall, competencies in project work in the team as well as in documentation and presentation of the work should be demonstrated. The report is included in the grade with 40 %, the presentation and the cooperation in the team with 30%.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge about:
- Power systems
- Renewable energies (potentials, technologies)
- Matlab / Simulink

Content:
These are research-related and practice-oriented tasks whose topics are in line with the current research areas of the chair, such as:
- Modeling, simulation and / or regulation of energy systems
- Investigation of the potential of renewable energies
- Analysis and generation of data for energy systems
- Evaluation and interpretation of model results
- Planning and installation of plants for the use of renewable energies on the Campus Garching

Intended Learning Outcomes:
After successfully completing the module, the student is - depending on the topic - able to:
- recognize challenges of integrating renewable energies,
- apply and implement appropriate tools and methods to analyze, plan or regulate energy systems,
- interpret and evaluate results from applied models.

Teaching and Learning Methods:
Project tasks are carried out individually or preferably in groups of 2-4 students. In the process, self-dependence respectively teamwork is supported in the processing of a project task. Depending on the topic, a literature research may be necessary. The main part of the project internship, however, is the computer-aided development of analysis and evaluation tools or the planning and execution of laboratory tests or installations.
The participants will finally have the opportunity to practice preparing and holding presentations.

Media:
- Application of various programs or programming languages (Matlab / Simulink, Python, etc.)
- Test benches (renewable energy conversion plants, real-time simulator, measuring instruments)
- Presentations

Reading List:
Konstantin, Panos: Praxisbuch Energiewirtschaft - Energieumwandlung, -transport und -beschaffung, Übertragungsnetzausbau und Kernenergieausstieg, Springer Vieweg, Springer-Verlag GmbH Deutschland, eBook ISBN 978-3-662-49823-1, DOI 10.1007/978-3-662-49823-1, Hardcover ISBN 978-3-662-49822-4

Wagner, Ulrich; Heilek, Christian (Bearb.): Nutzung regenerativer Energien (Vorlesungsskript), 10., vollständig überarbeitete Auflage, Herrsching, E & M, Energie-&-Management-Verl.-Ges., 2009, ISBN: 978-3-9805179-3-5

The Power of Transformation - Wind, Sun and the Economics of Flexible Power Systems, International Energy Agency, OECD/IEA, 2014, France, ISBN: 978 92 64 20803 2

Hillier, Frederick S., Lieberman, Gerald J.: Introduction to operations research, New York, McGraw-Hill Education, 2015, ISBN: 978-0-07-352345-3, 0-07-352345-3, 978-0-07-126767-0, 978-1-259-25318-8, 1-259-25318-X

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

Courses (Type of course, Weekly hours per semester), Instructor:
Projektpraktikum Erneuerbare und Nachhaltige Energiesysteme (Forschungspraktikum, 4 SWS)
Hamacher T, Kuhn P, Breuning L, Cadavid Isaza A, de la Rua Lope C, Halilovic S, Kerekes A, Kleeberger H
For further information in this module, please click campus.tum.de or here.

Electives | Wahlbereich

Module Description

EI80004: Sustainable Mobility | Sustainable Mobility [SuMo]

Sustainable Mobility: Current and Future Developments

Version of module description: Gültig ab winterterm 2018/19

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

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

Description of Examination Method:
The module exam consists of a 90-minute written exam, in which the students work on short word problems and multiple-choice questions on the different aspects of sustainability - especially with regard to the mobility sector. In addition, simple calculation tasks are used to check the mastery of the acquired procedures based on examples. In addition, students will use a case study to carry out the Life Cycle analysis using basic mathematical calculations. Word problems examine the understanding of the methods and the proper interpretation of results.
The exam is graded and no other documents are allowed.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fundamentals about:
- energy systems
- renewable energies

Content:
The lecture will cover the relevant questions concerning "sustainability" and "mobility" and methods to assess the sustainability of mobility systems.
- term sustainability: definition of sustainability
- tools for sustainability: (i) environmental life cycle analysis, (ii) life cycle cost analysis, (iii) social life cycle analysis and, (iv) socio-economic Input-Output Analysis.
- sustainability deficits of existing mobility: oil based system, geo-politics, CO2-emissions, particulate emissions, noise, ...

- new mobility concepts beyond technology: car sharing, inter modal transport
- electric vehicles and smart grid: current situation and challenges for sustainability.
- autonomous driving: current situation and challenges for sustainability
- other alternative fuels: current situation and challenges for sustainability

Intended Learning Outcomes:
After completing of the course, the student is able to:
- understand the term of sustainability
- understand the challenge that mobility represents to sustainability
- conduct a Life Cycle Analysis of different mobility options and assess the environmental impact (greenhouse gases, as well as other impacts) associated to different mobility systems from a life cycle approach
- conduct a Life Cycle Cost Analysis of different mobility options
- understand the socio-economic impacts of different systems using the macro-economic Input-Output Analysis.

Teaching and Learning Methods:
Case studies will be provided to the students, who will solve them using the methods learnt during the lectures
The exercises will be solved by the students during the session. The students will be encouraged to participate in the discussions

Language of instruction, English in Winter Semester and German in Summer Semester.

Media:
Lectures, presentations, blackboard and exercises.

Reading List:
Life cycle assessment student handbook
Hrsg./Bearb.: Curran, Mary Ann
Place of Publication, Publisher, Year of Publication: Hoboken, John Wiley & Sons Inc., 2015
Umfangsangabe: XI, 299 Seiten
ISBN: 978-1-119-08354-2

Life Cycle Assessment: Quantitative approaches for decisions that matter. Available at: http://www.lcatextbook.com/

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

Courses (Type of course, Weekly hours per semester), Instructor:
Sustainable Mobility (Übung, 1 SWS)
de la Rua Lope C, Cadavid Isaza A

Nachhaltige Mobilität (Vorlesung mit integrierten Übungen, 3 SWS)
Hamacher T, de la Rua Lope C, Cadavid Isaza A

Sustainable Mobility (Vorlesung, 2 SWS)
Hamacher T, de la Rua Lope C, Cadavid Isaza A
For further information in this module, please click campus.tum.de or here.

Module Description

MW2149: Introduction to Wind Energy | Introduction to Wind Energy

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 module examination consists of a written exam (90 minutes). The purpose of the exam is for students to demonstrate, within limited time, their ability in:
- Explaining the concepts that were covered during the lectures. This implies explaining, among the others, the main physical principles underlying the wind turbine aerodynamics and control, as well as the main features of the wind resource or the distinguish characteristics of offshore wind turbines.
- Solving problems that require using equations that were introduced during the lectures. This includes, among the others, computing the power and other operational parameters of a wind turbine under different environmental conditions, or determining the forces exerted by a section of a wind turbine blade.
Tools allowed in the exam: writing utensils, ruler, scientific non-programmable calculator and a note-sheet

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in engineering mechanics and aerodynamics.

Content:
" Introduction to wind energy, the wind resource and its characteristics.
" Wind turbine types, configurations, components, design of machines and wind farms.
" Wind turbine aerodynamics.
" Dynamics, aeroservoelasticity and control of wind turbines.
" Introduction to off-shore wind, the off-shore environment, support structures, dynamics.
" Introduction to electrical systems and grid integration.

Intended Learning Outcomes:
After participating to the module, students will be able to explain the basic principles underlying the energy conversion process from wind, with a particular emphasis on a multidisciplinary view of the problem. Furthermore, they will be able to master basic concepts concerning the aerodynamics, dynamics and control of wind turbines, and to apply them for the design and operation of wind turbines. Finally, students will be able to evaluate the best solutions for the conversion of mechanical energy into electrical energy, and how to best integrate both onshore and offshore wind farm power to the existing electrical grid.

Teaching and Learning Methods:
The module consists of both lectures and exercises. During the lectures, students are instructed in a teacher-centered style. This means, the main aspects of wind energy are presented by way of talks or presentations. Materials will be provided in an appropriate manner in time. With the information given, student learn to explain the basic principles underlying the energy conversion process from wind to electricity, with a particular emphasis on a multidisciplinary view of the problem.
The exercises are held in a student-centered way. Exercises are offered in advance for download , which will be worked through together in the exercise. The joint discussion and development of the solution are the basic principle of the exercises. The students are explicitly encouraged to ask questions and to express their solution approaches. With this, the students learn to apply basic concepts related to all principal aspects of wind energy technology, thus including the aerodynamics, dynamics and control of wind turbines, as well as their design and operation.

Media:
The following kinds of media are used:
- Class room lectures
- Lecture notes (handouts)
- Exercises with solutions as download

Reading List:
Course material will be provided by the instructor.
Additional recommended literature:
" T. Burton, N. Jenkins, D. Sharpe, E. Bossanyi, Wind Energy Handbook, Wiley, 2011.
" J. F. Manwell, J.G. McGowan, A.L. Rogers, Wind Energy Explained, Theory, Design and Application, Wiley, 2012.

Responsible for Module:
Bottasso, Carlo; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Introduction to Wind Energy (MW) (Übung, 2 SWS)
Bottasso C [L], Aktan H

Introduction to Wind Energy (MW) (Vorlesung, 2 SWS)

Bottasso C [L], Aktan H, Campagnolo F
For further information in this module, please click campus.tum.de or here.

Electives in Management and/or Technology | Wirtschaftswissenschaftlich-technische Wahlmodule

WahlKat-EE: Catalogue of Elective Modules: Economics & Econometrics | Wahlkatalog: Economics & Econometrics

Module Description

MGT001315: European Business Law | European Business Law [EBL]

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
In the final assessment students will need to demonstrate to what extent they have met the Learning Objectives. This assessment will be held as a written exam of 60 minutes.

In this exam students will be asked theoretical questions. This will demonstrate to what extent they have memorised and understood principles of EU law. Students will also be asked to apply their knowledge to known and fictional cases. This second part demonstrates if students have developed the required legal analytical skills, as well as the ability to apply their knowledge to fact settings not discussed in the lecture and to evaluate the legal consequences.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
This module provides on overview of the laws of the European Union that are relevant for national and international businesses.

Topics covered are the institutional framework of the EU, the relationship between the EU and national law, the concept of internal market & 5 freedoms, trade law, EU competition law, and EU IP & licensing agreements.

Intended Learning Outcomes:
At the end of this course students will be able (1.) to name and understand the rules and principles of EU law which are most important for businesses, (2.) to grasp and explain the framework of EU economic policies, in particular the interaction between EU law and member state law, (3.) to identify and analyse restrains prescribed by EU law from the perspective of businesses and employees, (4.) to assess real life scenarios regarding their EU law implications and to present the results of their analyses in a written memorandum.

Teaching and Learning Methods:
The lecture will cover the theoretical aspects of the module in a discussion with the lecturer. It will also provide the opportunity to work individually or in groups on case scenarios covering issues EU law. The purpose is to repeat and to intensify the content discussed in the lecture and to review and evaluate legal issues. This application facilitates the students' abilities to present their findings in writing.

Media:
Presentations (PPT), Reader, Case studies (including model answers)

Reading List:
Chalmers, Davies & Monti, European Union Law, 3rd edition 2018, Cambridge University Press.

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

Courses (Type of course, Weekly hours per semester), Instructor:
European Business Law - Exercise (MGT001315, englisch) (Übung, 2 SWS)
Duque Lizarralde M

European Business Law (MGT001315) (Vorlesung, 2 SWS)
Duque Lizarralde M
For further information in this module, please click campus.tum.de or here.

WahlKat-EM: Catalogue of Elective Modules: Modules Energy Markets | Wahlkatalog: Energy Markets

Module Description

WI001223: Challenges in Energy Markets | Challenges in Energy Markets

Global power plant projects in a changing energy market

Version of module description: Gültig ab summerterm 2021

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

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

Description of Examination Method:
The module examination is based on a written exam (60 minutes), which has two parts. The first part (≤ 20%) consists of multiple-choice questions, which test the students' understanding and basic knowledge of global energy markets, energy projects and manufacturers of energy technologies. The second part (≥ 80%) consists of open questions, where students have to show their ability to analyze and evaluate global energy projects, current developments and the challenges for manufactures of energy technologies, including the successful execution of large-scale power plant projects. Students moreover have to apply their ability to compare various financing models for different power plant types. Further, they have to apply theoretical concepts presented in the lecture.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
In the course of this module, students gain an overview of global power plant projects in a changing energy market. The module covers the following topics: general expectations for the energy market up to 2030; mix of power generation technologies; execution of energy projects into themes of project management; case studies for individual stages of project execution, challenges

and project risks; financing models of energy projects; supply chain management - exemplified by various power plant technologies; methods to implement innovation.

Intended Learning Outcomes:
After completion, students are able to analyze the fundamental changes taking place in the worldwide energy markets, the specific challenges, and the competitive environment. Further, they are able to outline how large-scale power plant projects are planned and successfully executed. They can also compare various financing models for the different types of power plants. Furthermore, they can analyze the importance of supply chain management for manufactures of various power technologies. Moreover, they can differentiate between various methods for implementing innovations. Finally, they are able to apply theoretical concepts to energy markets and manufacturers of energy technologies.

Teaching and Learning Methods:
The module is delivered through lecture and combines various learning methods:
- Basic knowledge, theoretical concepts and practical examples regarding energy markets are provided through the lecture.
- Controversial discussions and active participation in class are encouraged to deepen understanding of the contents presented.

Media:
Presentation, Exercises

Reading List:
- Burger, M.; Graeber, B.; Schindlmayr, G.: Managing Energy Risk: An Integrated View on Power and Other Energy Markets. John Wiley & Sons, 1st Edition, 2007.
- Erdmann, G.; Zweifel, P.: Energieökonomik – Theorie und Anwendungen. Springer, 2. Auflage, 2010.
- International Energy Agency, World Energy Outlook
- Konstantin, P.: Praxisbuch Energiewirtschaft. Energieumwandlung, -transport und –beschaffung im liberalisierten Markt. Springer, 2. Auflage, 2009.
- Schiffer, H.-W.: Energiemarkt Deutschland. TÜV-Media, 11. Auflage, 2010.
- Yergin, D.:The Quest-Energy, Security, and the Remaking of the Modern World, 2012.

Responsible for Module:
Schwenen, Sebastian; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Challenges in Energy Markets (WI001223) (Vorlesung, 2 SWS)
Schwenen S [L], Birnbaum L, Kiszka A
For further information in this module, please click campus.tum.de or here.

WahlKat-FA: Catalogue of Elective Modules: Finance and Accounting | Wahlkatalog: Finance & Accounting

Module Description

WIB23006: Advanced Seminar Finance & Accounting: Strategy Planning and Steering | Advanced Seminar Finance & Accounting: Strategy Planning and Steering

Strategy Planning & Steering

Version of module description: Gültig ab winterterm 2016/17

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

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

Description of Examination Method:
Grading is based on a seminar paper (max. 16 pages, 40%) and the presentations (10 minutes + 15 minutes discussion, 60%) of the elaborated case studies. The seminar paper should reveal the student's acquired knowledge about the respective seminar topic. Furthermore, the students should critically analyze the key aspects regarding their seminar topic. By presenting their findings in front of the class, students proof that they are able to present the key aspects in a concise manner and that they are able to answer further questions on their presented findings. The paper and the presentations will be processed in teams of 3-4 students, whereas the individual part of each student has to be clearly identifiable.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Working knowledge of the mandatory basic business courses

Content:
The module offers participants insights into the interaction of strategy, planning and steering processes and gives them the opportunity to examine one topic in more detail. Emphasis is put on the transfer and the adaptation of different models and philosophies onto specific industries and companies. The module may serve as a starting point for further research, but also prepares

participants for issues they are likely to face in their professional lives. Goal of the module is to develop a strategy plan and a business model for a company as well as a steering tool.

Intended Learning Outcomes:
After completing this module, students will have an advanced knowledge of the module's core topic. In particular, they will be able to write a seminar paper in an academic way, compile a literature review, and structure their work. Furthermore, students will be able to present their results, answer related questions, and to lead a discussion.

Teaching and Learning Methods:
This module is a seminar.
- working with Case studies
- working with academic papers

Media:
Books, case descriptions, academic papers, presentation slides

Reading List:
• Müller-Stewens, G., Lechner, C.(2005): Strategisches Management. Wie strategische Initiativen zu Wandel führen, 3. Auflage, Stuttgart: Schäffer-Poeschel Verlag
• Ku#nzel, H. (2016). Erfolgsfaktor Performance Management: Leistungsbereitschaft einer aufgekla#rten Generation. Berlin: Springer Gabler

Responsible for Module:
Mohnen, Alwine; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar Finance & Accounting (WIB23006): Strategy Planning & Steering (Seminar, 4 SWS)
Mohnen A, Stäglich J (Mitterer N)
For further information in this module, please click campus.tum.de or here.

Module Description

WI001263: Alternative Investments | Alternative Investments

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:
Examination is fully based on one written exam (120 minutes). The exam proofs students' knowledge and understanding of the typical invesment process an portfolio constructiosn in alternative assets. Furthermore, the exam tests students ability to use and critically analyze different valuation approaches. Students are allowed to use a non-programmable calculator during the exam.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Sound understanding of basics in corporste finance, portfolio theory and investing.

Content:
The course is divided in two parts: First, the alternative investment process and characteristics of its' asset classes (Private Equity, Venture Capital, Real Estate, Private Debt, Infrastructure, Impact Investments) are analyzed.

Second, the typical investors and fund managers in alternative investment funds are analyzed and the portfolio construction and investment process of a alternative investment funds will be discussed intensively.

Standard valuation methods are then analyzed as to their applicability in different contexts. Valuation methods include the discounted cash flow approach, and multiple approach. In addition, context-specific approaches to alternative assets' valuation are considered

Intended Learning Outcomes:
At the end of the module, students will be able to understand the alternative investment process and the sources of financing which are relevant in different constructs of alternative portfolio building.
In addition, students will be able to understand the business model alternative investment funds including their special refinancing and investment process. Furthermore, students will be able to evaluate contractual terms and conditions of alternative investment fund transactions. Finally, students will gain the skills to apply and analyze valuation methods which are suitable for entrepreneurial companies.

Teaching and Learning Methods:
Lecture with integrated comprehensive exercises. The content will be taught during the lectures and students should be motivated to analyze the topics and to work on sample questions that will be discussed during the lecture.

Media:
Powerpoint Slides, Whiteboard, Zoom

Reading List:
Achleitner, A.-K. / Nathusius, E. (2004): Venture Valuation Bewertung von Wachstumsunternehmen, Wiesbaden.
• Amis, D. / Stevenson, H. (2001): Winning Angels, London
Gompers, P./ Sahlman, W. A. (2002): Entrepreneurial Finance – A Casebook, New York.
• Scherlis, D. R. / Sahlman, W. A. (1989): A Method for Valuing High-Risk, Long-Term Investments - The "Venture Capital Method", Harvard Business School, Boston.
• Smith, J./Smith, R. (2004): Entrepreneurial Finance, 2nd Edition, Hoboken, NJ.
• Timmons, J./ Spinelli, S. (2007): New Venture Creation: Entrepreneurship for the 21st century, Boston

Responsible for Module:
Braun, Reiner; Prof. Dr. rer. oec.

Courses (Type of course, Weekly hours per semester), Instructor:
Alternative Investments (WI001263, englisch) (Vorlesung, 2 SWS)
Braun R [L], Braun R, Kay M, Schneider A

Alternative Investments (WI001263, englisch): Exercise (Übung, 2 SWS)
Braun R [L], Schneider A
For further information in this module, please click campus.tum.de or here.

WahlKat-IE: Catalogue of Elective Modules: Innovation & Entrepreneurship | Wahlkatalog: Innovation & Entrepreneurship

Module Description

MGT001395: Entrepreneurship and Innovation in China | Entrepreneurship and Innovation in China

Version of module description: Gültig ab winterterm 2022/23

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:
Each seminar participant will work individually on a specific topic in the field of entrepreneurship and innovation in China. Each student will write an academic essay (75% of the overall grade), based on existing literature on entrepreneurship and innovation in China. In their essay, the students will select a Chinese company of their choice, analyze its business model, position in the market, and how they fit into China's entrepreneurship and innovation ecosystem.

Students should demonstrate that they can:
• describe and evaluate a company's business model, degree of innovation and its position in the Chinese market
• draw conclusions and identify opportunities for future research
• write an essay that follows good academic writing practices, has a clear logic, and is based on academic literature

Students will present their work (25% of the overall grade) to an academic audience.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fluency in spoken and written English

Content:
This module explores entrepreneurship and innovation in China.

Before diving into several aspects of China's entrepreneurship ecosystem and national innovation system, we learn about China and analyze its economy.
Topics covered in the module are:
- China's Economy
- Innovation and entrepreneurship theory
- China's Innovation System and the history of entrepreneurship in China
- Green growth strategy
- Innovative unicorns and the Chinese venture capital market
- Research and education System
- Made in China (MIC) 2025 and beyond
- Corporate social credit system
- Intellectual property rights system
- Artificial intelligence
- Chinese women's entrepreneurship

Intended Learning Outcomes:
After completing the seminar, students should understand how entrepreneurship and innovation work in China.

After participating in this module, students can…
• summarize the historical development of private entrepreneurship in China
• describe the current state of (women) entrepreneurship in China
• name and critically reflect relevant stakeholders in China's national innovation system
• explain the relevance of China's start-up ecosystem and Chinese private companies
• evaluate the current state of entrepreneurship and innovation in China
• analyze the latest tech, entrepreneurship, and innovation trends

Moreover, students will be able to
• search, understand, synthesize, analyze, and apply academic literature
• present and discuss their findings and conclusions to an academic audience

Teaching and Learning Methods:
• The content of the course is transmitted via lectures, supported by power-point presentations, in which the instructor provides the theoretical foundations of entrepreneurship and innovation in China
• A strong focus of the course will be on existing academic literature, which will be discussed in class
• Group work (flip chart activities etc.) in the classes will be an essential part of this module, in which students jointly and critically reflect on the theories and insights presented in the module
• The content of the module is discussed in class by openly exchanging ideas and thoughts, creating a lively learning atmosphere
• Every session contains exercises (e.g., quizzes and discussion rounds), in which students apply their learning

• Other important real-life input will be given through multi-media resources and company case studies
• For their essays, students will investigate topics within the subject of this course. Students will receive feedback from the instructor
• In a final presentation, students present the results of their seminar essays
• The instructor offers weekly seminar-related office hourse for the students (offline and online)

Media:
Powerpoint, Quizzes, Flip chart activities, Word Clouds, etc.

Reading List:
Basic literature (for detailed reading list, see Moodle):

• Atherton, Andrew, and Alex Newman (2017), Entrepreneurship in China. The Emergence of the Private Sector, Routledge, Abingdon.
• Drucker, Peter Ferdinand (2006), Innovation and Entrepreneurship, HarperBusiness, London.
• Lardy, Nicholas R. (2014), Markets Over Mao: The Rise of Private Business in China, Peterson Institute for International Economics, Washington, DC.
• Lee, Kai-Fu (2018), AI Superpowers: China, Silicon Valley, and the New World Order, Houghton Mifflin, New York.
• Lee, Kai-Fu and Qiufan Chen (2021), AI 2041. Ten Visions for our Future, WH Allen, London.
• Naughton, Barry (2007), The Chinese Economy. Transition and Growth. The MIT Press, Cambridge.
• OECD/Eurostat (2018), “Oslo Manual 2018: Guidelines for Collecting, Reporting, Using Data on Innovation, 4th Edition, The Measurement of Scientific, Technological and Innovation Activities”, OECD Publishing, Paris. https://doi.org/10.1787/24132764.
• Roberts, Huw, Josh Cowls, Jessica Morley, Mariaosaria Taddeo, Vincent Wang and Luciano Floridi (2020) “The Chinese approach to artificial intelligence: an analysis of policy, ethics, and regulation“, AI and Society, Vol. 36 No. 1, 59-77.
• Schaper, Anna-Katharina (2023), “Let’s add the land of the pandas to our research agenda. Why female entrepreneurship in China matters”, Entrepreneurship Blog of the University of Siegen, https://blogs.uni-siegen.de/modernentrepreneurship/2023/01/09/lets-add-the-land-of-the-pandas-to-our-research-agenda-why-female-entrepreneurship-in-china-matters/.
• Schaper, Anna-Katharina and Doris Fischer (2021), “Does Gender Matter for the Entrepreneurship Fairy Tale? An Analysis of Chinese Unicorn Start-ups”, CBE Research Notes 02/2021, University of Würzburg, Würzburg. https://opus.bibliothek.uni-wuerzburg.de/opus4-wuerzburg/frontdoor/deliver/index/docId/24441/file/CBE_RN02_Schaper_Fischer.pdf
• Tse, Edward (2015), China‘s Disruptors: How Alibaba, Xiaomi, Tencent, and other Companies are Changing the Rules of Business. Penguin, New York.
• World Economic Forum (WEF) (2020), The Global Competitiveness Report 2019, Geneva. http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf.
• Yueh, Linda (2019), Enterprising China. Business, Economic, and Legal Developments since 1979, Oxford University Press, Oxford.

Responsible for Module:
Richards, Melanie; Prof. Dr. oec.

Courses (Type of course, Weekly hours per semester), Instructor:
Entrepreneurship and Innovation in China (MGT001395, englisch) (Limited places) (Seminar, 4 SWS)
Schaper A
For further information in this module, please click campus.tum.de or here.

WahlKat-LSMP: Catalogue of Elective Modules: Life Sciences Management & Policy | Wahlkatalog: Life Sciences Management & Policy

Module Description

WI000948: Food Economics | Food Economics

Version of module description: Gültig ab summerterm 2021

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

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

Description of Examination Method:
Students prove their achievement of learning outcomes in an oral exam of 25 minutes. The exam is designed to test whether students understand the discussed topics and publications, whether they can describe and explain them in a meaningful and exact way, and whether they can critically reflect on assumptions, methodology, results, and political and societal implications of research in food economics. An oral exam is the most suitable format to account for the discursive and reflective nature of the abilities examined.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The course applies microeconomic theory to study questions of food demand and supply. Students should feel comfortable with the material in microeconomic courses at introductory level.

Content:
The course is intended to provide students with in-depth coverage of food economics with an emphasis on trends and phenomena of food markets and value chains, food labelling, food safety, food consumption, nutrition and food policy. Taking examples from these domains the course introduces a variety of economic models that are being used in food-economic research.

Intended Learning Outcomes:
At the end of the module, the students are able to (1) outline important trends and phenomena in food markets in Germany, Europe and the world, (2) analyse consumer and firm behavior in

food markets based on economic theory, (3) assess the effectiveness of food policy instruments, (4) acquaint themselves with scientific literature in the area of food economics and discuss and evaluate crucial assumptions, choice of methodology and implications of results.

Teaching and Learning Methods:
The module is designed as an interactive lecture where both lecturers and students provide input for discussion. In order to set up a common basis for participants, lecturers present information on major features and trends on food markets and economic concepts used to analyze them. To familiarize themselves with economic research, students read selected journal articles from the field of agricultural and food economics and prepare a short presentation of 15 minutes and a short report of about 2 pages once per semester, summarising the main hypotheses, methods applied, results obtained and implications derived. Subsequent discussions in classroom on assumptions, limitations of data and methods, as well as on different ways to interprete results deepen students' understanding of the potential and restrictions of research in food economics.

Media:
Slides, textbooks, journal articles, blackboard, collection of summaries of publications.

Reading List:
Lusk, J. L., Roosen, J, & Shogren, J. F. (eds.) (2011). The Oxford handbook of the economics of food consumption and policy. Oxford University Press: New York.
Additional references are provided in the course.

Responsible for Module:
Roosen, Jutta; Prof. Dr. Ph.D.

Courses (Type of course, Weekly hours per semester), Instructor:
Food Economics (WI000948) (Vorlesung, 4 SWS)
Roosen J, Menapace L, Rackl J, Ola O
For further information in this module, please click campus.tum.de or here.

WahlKat-MM: Catalogue of Elective Modules: Management & Marketing | Wahlkatalog: Management & Marketing

Module Description

WI001140: Luxury Marketing | Luxury Marketing

Version of module description: Gültig ab summerterm 2017

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 final grade is based on group presentations. During the module two presentations have to be held. One short presentation (25% of grade, presenting an article - 20 min) aims to prove if students are able to connect the theoretical material on luxury marketing with empirical results of the contemporary research, if they are able to analyze and present an academic article in a clear and organized way, and if their able to provide a personal interpretation of the article. The second presentation (75% of grade, 45 min) assesses if the students understand the main elements of a luxury strategy with a focus on the 4Ps, and if they are able to apply the theoretical learning to a real case by conducting an audit of a luxury brand and by giving recommendations of how to improve the luxury marketing strategy of the assigned brand. They can use the theoretical material (lecturer´s slides) as a support and they have to collect secondary data. This presentation is combined with a written composition that illustrates the results of the audit. The presentations are done by groups of four students. The students will receive an individual grade: the individual contribution will be identified by evaluating a personal recommendation to the luxury brand that each students has to provide as a result of the audit, and by evaluating the individual communication skills. Both presentations are followed by a discussion in which all the students can voluntarily participate.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

Content:
* First, the module starts with a discussion about how the meaning of luxury evolved from the past until now. It will elaborate how luxury differs from other related concepts.
* Second, it will focus on understanding consumer behavior association with luxury products and brands. In particular, it will identify the underlying drivers of conspicuous consumption (e.g. self-reward, social elevation) and what consumers want to signal through the purchase of luxury products (e.g. status, wealth, power).
* Third, the module will discuss best practices, do's and don'ts, when it comes to building, managing, and extending luxury brands. Especially, the symbolic power and the identity of luxury brands will be discussed.
* Last but not least, it will discuss the 4Ps of luxury marketing and how to leverage them to develop an effective marketing strategy.

Intended Learning Outcomes:
Upon successful completion of this module, students are able (1) to understand the basic elements and the specific challenges of marketing luxury products and (2) to give examples from empirical evidence of the theoretical concepts. They are also able (3) to analyze, (4) review and (5) present academic papers related to the topic of luxury of the contemporary research. Finally, they are able (6) to conduct an audit of a luxury brand (7) by making recommendations to improve the luxury marketing strategy of the assigned brand and (8) to improve their communication skills.

Teaching and Learning Methods:
The module uses various teaching methods that should help facilitate students' learning. The students are provided during the lectures with theoretical material to acquire the basic knowledge of luxury marketing. The students have to present academic papers in class and discuss them with peers, in order to explore empirical results related to theoretical concepts. They also have to prepare an audit of a luxury brand focused on the 4Ps (product, price, promotion, and place), which they have to present in class, in order to apply in practice the theoretical learning. The audit can be performed using the theoretical material presented in class as a support.

Media:

Reading List:
- Han, Y. J., Nunes, J. C., & Drèze, X. (2010). Signaling status with luxury goods: The role of brand prominence. Journal of Marketing, 74(4), 15-30.
- Wang, Y., & Griskevicius, V. (2014). Conspicuous consumption, relationships, and rivals: Women's luxury products as signals to other women. Journal of Consumer Research, 40(5), 834-854.
- Bellezza, S., Gino, F., & Keinan, A. (2014). The red sneakers effect: Inferring status and competence from signals of nonconformity. Journal of Consumer Research, 41(1), 35-54.
- Mandel, N., Petrova, P. K., & Cialdini, R. B. (2006). Images of success and the preference for luxury brands. Journal of Consumer Psychology, 16(1), 57-69.

- Rucker, D. D., & Galinsky, A. D. (2008). Desire to acquire: Powerlessness and compensatory consumption. Journal of Consumer Research, 35(2), 257-267.
- Griskevicius, V., Tybur, J. M., & Van den Bergh, B. (2010). Going green to be seen: status, reputation, and conspicuous conservation. Journal of personality and social psychology, 98(3), 392.
- Hagtvedt, H., & Patrick, V. M. (2008). Art and the brand: The role of visual art in enhancing brand extendibility. Journal of Consumer Psychology, 18.
- Hagtvedt, H., & Patrick, V. M. (2009). The broad embrace of luxury: Hedonic potential as a driver of brand extendibility. Journal of Consumer Psychology, 19.
- Fuchs, C., Prandelli, E., Schreier, M., & Dahl, D. W. (2013). All that is users might not be gold: How labeling products as user designed backfires in the context of luxury fashion brands. Journal of Marketing, 77(5), 75-91.
- Wilcox, K., Kim, H. M., & Sen, S. (2009). Why do consumers buy counterfeit luxury brands?. Journal of Marketing Research, 46(2), 247-259.
- Willems, K., Janssens, W., Swinnen, G., Brengman, M., Streukens, S., & Vancauteren, M. (2012). From Armani to Zara: Impression formation based on fashion store patronage. Journal of Business Research, 65(10), 1487-1494.
- Ward, M. K., & Dahl, D. W. (2014). Should the Devil Sell Prada? Retail Rejection Increases Aspiring Consumers' Desire for the Brand. Journal of Consumer Research, 41(3), 590-609.

Responsible for Module:
Fuchs, Christoph; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Luxury Marketing (WI001140, englisch) (limited places) (Vorlesung, 4 SWS)
Caprioli S
For further information in this module, please click campus.tum.de or here.

WahlKat-OSCM: Catalogue of Elective Modules: Operations & Supply Chain Management | Wahlkatalog: Operations & Supply Chain Management

Module Description

WI000819: Applied Discrete Optimization | Applied Discrete Optimization [DO]

Version of module description: Gültig ab winterterm 2012/13

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:
Exercises (Any combination of homework assignments, semester project or report, and presentation) and
Test (written)

The final grade is composed of individual or group exercises, as well as a written individual test at the end of the semester. The exercises will count for 40%-60% and the test for 60%-40% respectively, of the final grade.

In the exercises, the students show their theoretical understanding and, thus, ability to apply different methodologies, either exact or heuristic, to solve problems including the real-world applications in the field of operations research. In the test, the theoretical understanding of each student is queried.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:

This module is dedicated to advanced students who have background in Management Science or Operations Research, specifically in linear programming and duality theory. To work on the assignments, students should have knowledge in using any optimization packages such as OPL/

CPLEX, GUROBI, LINGO, or Excel Solver. Knowledge in programming languages is not expected but can be useful for the assignments.

Content:
Discrete optimization problems arise in many practical applications and functional areas. The module Applied Discrete Optimization focuses on the underlying polyhedral theory and both exact and heuristic solution methods to solve
large - scale and complex mathematical models. Topics include
1. Review of linear programming
2. Revised simplex and column generation methods
3. Discrete optimization problems and model formulations
4. Computational complexity
5. Basic exact solution methods:
a. Branch-and-Bound methods
b. Cutting-Plane methods
6. Advanced exact solution methods:
a. Strong Valid Inequalities
b. Branch-and-Cut
c. Dantzig-Wolfe Decomposition
d. Branch-and-Price / Branch-Price-Cut
e. Lagrangian Relaxation
f. Bender’s Decomposition
7. Heuristic / Metaheuristic methods

Intended Learning Outcomes:
At the end of the module, students shall understand the complexity of discrete optimization models, the polyhedral theory, and the theoretical concepts underlying the advanced methods in solving the discrete models. These methods include Branch-and-Cut, Branch-and-Price, Branch-Price-Cut, Benders' Decomposition, and Lagrangian relaxation. Students will be able to apply appropriately these solution approaches to solve their complex problems either by exact or heuristic methods.

Teaching and Learning Methods:
The module consists of a series of lectures that describe the fundamental theories behind the solution methods and illustrate their examples and applications. A few selected technical papers addressing specific problems and solutions to the described problems will be discussed. Assignments are of student groupwork to practice the solution methods learned in class and to review the real-world applications.

Media:

Reading List:

1. Nemhauser G.L. and L.A. Wolsey. Integer and Combinatorial Optimization. Wiley. 1988.

2. Wolsey, L.A. Integer Programming. Wiley. 1998.
3. Wintston, Operations Research: Applications and Algorithms. 1993.
4. Any reference or textbook in management science or operations research.

Responsible for Module:
Kolisch, Rainer; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Applied Discrete Optimization (WI000819, englisch) (Vorlesung mit integrierten Übungen, 4 SWS)
Schulz A
For further information in this module, please click campus.tum.de or here.

Catalogue of Elective Modules: Mechanical Engineering | Wahlkatalog: Maschinenwesen

Module Description

MW1920: Machine Dynamics | Maschinendynamik

Version of module description: Gültig ab summerterm 2014

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

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

Description of Examination Method:
Schriftliche Prüfung nach Abschluß der Vorlesung und Übung. In der Prüfung müssen in einem ersten Teil Verständnisfragen beantwortet und in einem zweiten Teil Aufgaben mittels Rechnung analytisch gelöst werden.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse zur Kinematik und Kinetik am gegebenen Berechnungsmodell mit wenigen Freiheitsgraden werden aus der Mechanikausbildung im Bachelorstudium oder im Vordiplom vorausgesetzt.

Content:
Der Student lernt Minimalmodelle und Differentialgleichungen für typische Phänomene der Maschinendynamik kennen. Der Übergang vom realen Objekt zum Modell wird besprochen. Folgende Inhalte sind Schwerpunkte der Vorlesung:
- Modellbildung und Parameteridentifikation (Einführung in die Theorie der Mehrkörpersysteme)
- Starrkörper-Mechanismen (Massen- und Leistungsausgleich, Eigenbewegung)
- Maschinenaufstellung (Fundamentierung, Schwingungsisolation)
- Rotorsysteme (Auswuchten, Kreiselwirkung, Instabilität durch innere Dämpfung)
- Schwingungsfähige Mechanismen (Elastizität am Ab- oder Antrieb)
- Modale Betrachtung von Schwingungssystemen
- Tilger (getunter Zusatzschwinger)
- Dämpfung (Ansätze, Parameter, Eigenwerte und -vektoren)

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung ist der Studierende in der Lage typische Phänomene der Maschinendynamik zu unterscheiden und bei konkreten Problemstellungen an einem realen Objekt zu erkennen. Darauf aufbauend ist der Studierende fähig, die in der Vorlesung vermittelten Inhalte zur Analye und Bewertung heranzuziehen, um das dynamische Verhalten im konkreten Fall richtig einschätzen zu können. Weiterhin ist es dem Studierenden möglich mit den in der Vorlesung erläuterten Maßnahmen das Schwingungsverhalten von dynamischen Systemen zu verbessern.

Teaching and Learning Methods:
Vorlesung, Übung, Bereitstellung funktionsfähiger Matlab-Simulationen zum Selbststudium, Bereitstellung eines Fragenkataloges (ca. 130 Fragen) als roter Faden zur Prüfungsvorbereitung

Media:
Präsentation (Tablet-PC), Skript online verfügbare Vorlage und auch als Vorlesungsmitschrift bzw. Übungsmitschrift

Handouts zu mathematischen Grundlagen

Videos von Praxisbeispielen und Animationen zu Schwingungsvorgängen

Reading List:
Dresig, H.; Holzweißig, F.: Maschinendynamik. Springer-Verlag Berlin Heidelberg, 9., neu bearbeitete Auflage 2009, mit 60 Aufgaben und Lösungen Gasch, R.; Nordemann, R.; Pfützner, H.: Rotordynamik. Springerverlag Berlin u.a., 2., vollst. neubearb. und erw.
Auflage 2002

Responsible for Module:
Rixen, Daniel; Prof. Dr.

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

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

Catalogue of Elective Modules: Mechanical Engineering (advanced) | Wahlkatalog: Maschinenwesen (advanced)

Module Description

MW1921: Material Flow and Logistics | Materialfluss und Logistik

Version of module description: Gültig ab summerterm 2013

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

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

Description of Examination Method:
Students apply the lecture's contents in a written exam (duration: 90 minutes) with questions and calculation tasks. The only aid allowed is a non-programmable calculator. In this way, students demonstrate different abilities: to analyze logistics systems, logistics processes and logistics structures; to apply methods for planning of such structures; to understand the key functions of physical logistics.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
From a higher point of view, the module explains the tasks, aims, key indicators and impact factors of logistics. Common structures of production and distribution are presented along with according control strategies. Besides key functions of material flow-transportation, distribution/consolidation, storage, order picking and handling-methods to model material flow systems are taught, e. g. flow charts, graphs, material flow matrices and layouts. Methods to analyze system behavior complete the module; they comprise static dimensioning, event-discrete simulation, queuing theory and the concept of availability.
Additionally, the module contains the following contents:
Logistics systems: Design guidelines; logistical processes, functions, and structures; logistical networks; methods for planning logistical structures

Logistics management: Control and coordination in logistics systems, supply chain management, information management

Intended Learning Outcomes:
Having completed the module, students know about key tasks and aims of logistics. They are able to analyze logistics systems, logistical processes and logistical structures. Furthermore, they can apply methods to plan logistical structures and know means of control and coordination in logistics systems and concepts of information management.
In addition, students understand the key functions of physical logistics and are able to apply methods to depict material flow and to dimension and evaluate logistics systems.

Teaching and Learning Methods:
Contents are explained by lectures and by exemplary applications from industrial practice. Supporting the lectures, students have access to a detailed collection of slides, exercises and sample solutions.
In tutorials, exercises demonstrate the applicability of the lectures' theoretical contents.
All documents and further information are accessible online and free via elearning. During office hours of scientific staff, individual questions and problems can be discussed.

Media:
Lectures: Talk with tablet and projector, board and overhead projector; printed scriptum (fee-based)
Online documents: Documents for exercises with sample solutions; scriptum (digital as PDF, free of charge)

Reading List:
Aggteleky, B.: Fabrikplanung: Werksentwicklung und Betriebsrationalisierung, Band 1-3. München, Wien: Hanser, 1987 (Band 1) und 1990 (Band 2 und 3)
Arnold, D.: Materialflusslehre. Braunschweig, Wiesbaden: Vieweg, 1998
Dangelmaier, W.: Fertigungsplanung. Düsseldorf: VDI-Verlag, 2001
Gudehus, T.: Logistik: Grundlagen, Strategien, Anwendungen. Berlin u.a.: Springer, 2005
Großeschallau, W.: Materialflussrechnung. Berlin u.a.: Springer, 1984
Kettner, H., Schmidt, J., Greim, H.-R.: Leitfaden der systematischen Fabrikplanung. München, Wien: Hanser, 1984
Jünemann, R.: Materialfluss und Logistik: Systemtechnische Grundlagen mit Praxisbeispielen. Berlin u.a.: Springer, 1998
Jünemann, R., Schmidt, T.: Materialflusssysteme: Systemtechnische Grundlagen. Berlin u.a.: Springer, 1999
Pfohl, H.-C.: Logistiksysteme: Betriebswirtschaftliche Grundlagen.
Berlin u.a.: Springer, 2004
VDI-Gesellschaft Fördertechnik Materialfluss Logistik (Hrsg.).
VDI-Handbuch Materialfluss und Fördertechnik: Band 1 8.
Düsseldorf: VDI-Verlag
Wildemann, H.: Logistik Prozessmanagement. München: TCW Transfer-Centrum, 2005

Wiendahl, H.-P.: Fertigungsregelung: Logistische Beherrschung von Fertigungsabläufen auf Basis des Trichtermodells. München, Wien: Hanser, 1997

Responsible for Module:
Fottner, Johannes; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Materialfluss und Logistik Übung (Übung, 1 SWS)
Grohs L [L], Fottner J (Vollmuth P)

Materialfluss und Logistik (Vorlesung, 2 SWS)
Grohs L [L], Fottner J (Vollmuth P)
For further information in this module, please click campus.tum.de or here.

Catalogue of Elective Modules: Informatics | Wahlkatalog: Informatik

Module Description

IN0003: Functional Programming and Verification | Funktionale Programmierung und Verifikation

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
The exam takes the form of a 120 minutes written test. Small programming tasks allow to assess whether the students master a functional programming language and are able to realize small implementation problems. By inferring simple invariants they demonstrate that they have understood the principles of program verification and are able to apply these.
The successful completion of homework asignments may contribute to the grade as a bonus. The exact details for this are announced timely at the begin of the lecture.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
IN0001 Introduction to Informatics

Content:
Among others, the module IN0003 is concerned with the following topics:
- Correctness of imperative programs
++ Verification according to Floyd or Hoare
++ Termination
++ Procedures
- Basic concepts of functional programming
++ Values, variables, functions
++ Data++structures, pattern matching
++ Higher order functions
++ Polymorphic types

++ Programming in the large: Structures and Functors
++ Correctness of functional programs
+++ Semantics of functional programs
+++ Verification of functional programs

Intended Learning Outcomes:
After successful completion of the module, participants understand the key concepts of functional programming languages. They are able to solve well presented tasks in a functional programming language. Therefore, they are able to acquire programming skills on their own also in further functional programming languages. They also are familiar with the most important techniques for the verification of imperative and functional programming language and can apply them to simple programs.

Teaching and Learning Methods:
By means of a presentation, either by slides or whiteboard, the lecture transports the concepts of verification and the programming language and illustrates them by examples.
Accompanying assignments for individual study deepen the understanding of the concepts explained in the lecture, and train students to apply these to the verification of small programs and to master programming in the given programming language.

Media:
Slide show, blackboard, possibly online programming and/or animations

Reading List:
Guy Cousineau und Michel Mauny, The Functional Approach to Programming, Cambridge University Press, Cambridge, 1998
Apt, Olderog: Programm-Verifikation. Springer 1991
Gerd Smolka: Programmierung - eine Einführung in die Informatik mit Standard ML. Oldenburg, 2007
Simon Tompson: Haskell: the Craft of Functional Programming. Addison-Wesley, 2011

Responsible for Module:
Seidl, Helmut; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Übungen zu Funktionale Programmierung und Verifikation (IN0003) (Übung, 2 SWS)
Seidl H [L], Erhard J, Schwarz M, Seidl H

Funktionale Programmierung und Verifikation (IN0003) (Vorlesung, 2 SWS)
Seidl H [L], Erhard J, Schwarz M, Seidl H
For further information in this module, please click campus.tum.de or here.

Catalogue of Elective Modules: Informatics (advanced) | Wahlkatalog: Informatik (advanced)

Module Description

IN2346: Introduction to Deep Learning | Introduction to Deep Learning

Version of module description: Gültig ab summerterm 2018

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

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

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

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

Repeat Examination:
Next semester

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

MA0902 Analysis for Informatics
MA0901 Linear Algebra for Informatics

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

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

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

Media:
Projector, blackboard, PC

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

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

Courses (Type of course, Weekly hours per semester), Instructor:
Introduction to Deep Learning (IN2346) (Vorlesung mit integrierten Übungen, 4 SWS)
Dai A [L], Chen Y, Dahnert M, Dai A, Huang J
For further information in this module, please click campus.tum.de or here.

Catalogue of Elective Modules: Chemistry | Wahlkatalog: Chemie

Module Description

CH0107: Analytical Chemistry | Analytische Chemie

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
Die Prüfungsleistung wird in Form einer Klausur (60 Minuten) erbracht. In dieser soll nachgewiesen werden, dass in begrenzter Zeit und ohne Hilfsmittel die verschiedenen Schritte moderner Analytik von der Probenahme bis zur Auswertung erkannt und gängige instrumentelle Analyseverfahren erinnert werden können. Die Antworten erfordern teils eigene Berechnungen und Formulierungen teils Ankreuzen von vorgegebenen Mehrfachantworten.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Grundwissen in Chemie und Physik.

Content:
Der Analytische Prozess: Probennahme, Probenvorbereitung, Detektions- und Bestimmungsverfahren, Validierung der Ergebnisse, Qualitätssicherung. Instrumentelle Analytik, u.a. AAS, OES, RFA, MS, Kopplungstechniken. Illustrative Beispiele moderner Elementanalytik.

Intended Learning Outcomes:
Nach der Teilnahme am Modul sind die Studierenden in der Lage, die einzelnen Schritte einer chemischen Analyse von Probenahme, Probenaufbereitung, Messung, Auswertung und Validierung zu erinnern und deren Eigenheiten und Wichtigkeit zu verstehen und anzuwenden. Sie können verschiedene moderne Analyseverfahren wie AAS, OES, RFA, MS und Kopplungsverfahren benennen und erklären.

Teaching and Learning Methods:
Das Modul besteht aus einer Vorlesung deren Inhalt im Vortrag und durch Präsentationen vermittelt wird. Studierende werden zur inhaltlichen Auseindersetzung mit der Thematik und zum Studium der Literatur angeregt.

Media:
Bücher, Online-Skript

Reading List:
Skoog, Douglas A., Holler, F. James, Crouch, Stanley R. Niessner, R. (Hrsg.), Instrumentelle Analytik Grundlagen - Geräte Anwendungen. Springer 2013, 6. Auflage.
Harris, Daniel C., Werner, Gerhard, Werner, Tobias (Hrsg.), Lehrbuch der Quantitativen Analyse. Springer 2014, 8. Auflage.

Responsible for Module:
Strittmatter, Nicole; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Analytische Chemie (CH0107) (Vorlesung, 2 SWS)
Strittmatter N (Ivleva N)
For further information in this module, please click campus.tum.de or here.

Catalogue of Elective Modules: Chemistry (advanced) | Wahlkatalog: Chemie (advanced)

Module Description

CH4117: Biochemistry | Biochemie

Version of module description: Gültig ab winterterm 2018/19

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

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

Description of Examination Method:
Die Prüfungsleistung wird schriftlich in Form einer 90 minütigen Klausur erbracht. In dieser soll nachgewiesen werden, dass biochemische Stoffwechselwege für den Metabolismus von organischen Verbindungen zur Umsetzung von ATP im Detail verstanden worden sind. Ferner soll das Verständnis über den Aufbau von Biomolekülen (z.B. allgemeine Enzymklassen, Kohlenhydrate, Lipide, Protein, Nukleinsäuren) und die Eigenschaften ihrer Reaktivitäten geprüft werden. In der Klausur sind darüber hinaus Fragestellungen zur Biosynthese, Reaktivität und Stabilität Stoffwechselmetaboliten zu bearbeiten. Die Prüfungsfragen gehen über den gesamten Modulstoff. Die Antworten erfordern teils eigene Berechnungen und Formulierungen teils Ankreuzen von vorgegebenen Mehrfachantworten. Es sind keine Hilfsmittel erlaubt.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Hilfreich: "Aufbau und Struktur organischer Verbindungen"; "Reaktivität organischer Verbindungen" und "Grundlagen der Physikalischen Chemie".
Dringend empfohlen: "Biologie für Chemiker".

Content:
Generell behandelt das Modul alle grundlegenden iochemischen zellulären Stoffwechselwege. Der detaillierte Fokus liegt auf dem Verständnis der enzymatischen Grundprinzipien zur Umsetzung von Biomolekülen. Die chemischen Reaktionswege des stoffwechsels werden im Detail besprochen, wie oxidoreduktionen, Ligationen, Isomerisierungen, Transferreaktionen, Hydrolysereaktionen, Addition/Eliminierung, etc.. Die organisch-chemischen Grundlagen

unterschiedlicher Funktionalitäten sowie die individuellen Co-Enzyme mit deren Besonderheiten werden im Kontext der zellulären Anforderungen molekularbiologisch diskutiert. Ein weiterer fundamentaler Aspekt ist die Bedeutung des Energiestoffwechsels hinsichtlich des Umsatzes von ATP.

Einzelne Inhalte sind:
Einleitung: Enzyme und die molekularen Aspekte ihrer Wirkung
1. Glykolyse
2. Pentosephosphatweg
3. Zitronensäurezyklus
4. Aminosäureabbau
5. Fettsäuremetabolismus
6. Nukleotidstoffwechsel
7. Atmungskette
8. Photosynthese
9. Vernetzung der unterschiedlichen Stoffwechselwege in der Zelle.

Intended Learning Outcomes:
Nach der Teilnahme am Modul "Biochemie" verstehen die Studierenden die chemischen Grundlagen der metabolischen Stoffwechselwege und deren zelluläre Vernetzung. Des Weiteren sind sie in der Lage, organisch-chemische Reaktionen für biochemische Prozesse auswerten und interpretieren zu können. Sie können tiefgreifende enzymatische Strategien verstehen und anwenden um metabolische Konversionen zu erreichen. Durch die Verknüpfung der molekularen Aspekte der Enzymfunktion und der chemischen Grundlagen von primären Stoffwechselmetaboliten können die Studierenden die Logik von biologischen Problemen nachvollziehen.

Teaching and Learning Methods:
Das Modul besteht aus einer Vorlesung (2 SWS) und einer begleitenden Übung (1 SWS). Die Inhalte der Vorlesung werden im Vortrag und Präsentationen behandelt. Begleitend sollen die Studierenden ein Lehrbuch durcharbeiten, welches zur weiteren Vertiefung auch durch weitere Literatur ergänzt werden kann. In der Übung werden die Inhalte der Vorlesung in anschaulichen Beispielen rekapituliert.
Das Modul dient der Vorbereitung der Studierenden auf die Vertiefungsfächer im Masterstudium, wie z.B. Molekulare Medizin, Bioanorganische Chemie, Biologische Chemie, Naturstoffsynthese.

Media:
Die in der Vorlesung verwendeten Medien setzen sich aus Präsentationen und Tafelaufschrieben zusammen, um den Studierenden Kenntnisse der Biochemie zu vermitteln. Die Übung dient der Anwendung und Vertiefung der erlernten Kenntnisse der Biochemie. Es wird ein Aufgabenblatt für die Übung zum Vorlesungsstoff zum Herunterladen hinterlegt. Die Musterlösung wird in einer eigenen Übungsstunde an der Tafel vorgeführt. Die Studierenden sollen zum Studium der Literatur und der inhaltlichen Auseinandersetzung mit den Themen angeregt werden.

Reading List:
Als Lehrbuch begleitend zur Vorlesung:
Berg JM, Tymoczko JL, Stryer L: Biochemie, 7. Aufl., Springer Spektrum Verlag 2012, ISBN 3827429889.
Voet D, Voet JG, Pratt CW: Lehrbuch der Biochemie, 2. Aufl., Wiley VCH, Weinheim, ISBN 9783527326679.

Responsible for Module:
Groll, Michael; Prof. Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Biochemie (CH4117) (Vorlesung, 2 SWS)
Groll M, Hagn F

Biochemie, Übung (CH4117) (Übung, 1 SWS)
Hagn F, Huber E
For further information in this module, please click campus.tum.de or here.

Catalogue of Elective Modules: Electrical Engineering and Information Technology | Wahlkatalog: Elektro-/ Informationstechnik

Module Description

EI0625: Communication Networks | Kommunikationsnetze

Version of module description: Gültig ab winterterm 2015/16

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

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

Description of Examination Method:
Im Rahmen einer 90 minütigen schriftlichen Klausur wird überprüft, inwieweit Studierende die Kommunikationsnetzen und deren Funktionsblöcken zugrundeliegenden Konzepte wiedergeben können. Dafür müssen Studierende Fragen beantworten und Analysemethoden zur Netzbewertung einsetzen und Optimierungsmöglichkeiten aufzeigen können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
keine Voraussetzungen.

Content:
* Übertragungsverfahren, Multiplextechniken, Durchschalte- und Paketvermittlung, Signalisierung, Adressierung, Nachrichtenaustausch
* Leistungsbewertung, Einführung in die Verkehrstheorie (Berechnung von Verlust- und Wartesystemen)
* Grundlegende Kommunikationsprotokolle (ARQ, Fensterprotokolle)
* Netzstrukturen, Netzgraphen, Algorithmen, Routing
* Einführung in die Netzplanung und Optimierung
* Fehlertoleranz und Verfügbarkeit
* Mobilitätsmanagement
* Beispiele heutiger Netze (Internet, Telefonnetz, Mobilfunknetz), Dienste, Anwendungen, Architekturkonzepte

Intended Learning Outcomes:
Nach erfolgreichem Abschluss des Moduls ist die Studierende/der Studierende in der Lage, grundlegende Konzepte von Kommunikationsnetzen und deren Funktionsblöcke zu verstehen, grundlegende graphen- und verkehrstheoretische Analysemethoden zur Netzbewertung, grundlegende Methoden des Protokollentwurfs, der Netzplanung und Optimierung sowie Routingverfahren anzuwenden.

Teaching and Learning Methods:
Als Lernmethode wird zusätzlich zu den individuellen Methoden der Studierenden/des Studierenden eine vertiefende Wissensbildung durch mehrmaliges Aufgabenrechnen in Übungen angestrebt.

Als Lehrmethode wird in der Vorlesungen Frontalunterricht, in den Übungen Arbeitsunterricht (Aufgaben rechnen) gehalten.

Zusätzlich erarbeiten die Studierenden selbsständig anhand wissenschaftlicher Fachartikel weitere Grundlagen und üben damit das Lesen und Verstehen wissenschaftlicher Literatur.

Media:
Folgende Medienformen finden Verwendung:
- Präsentationen
- Skript
- Übungsaufgaben mit Lösungen als Download im Internet
- ausgewählte wissenschaftliche Aufsätze

Reading List:
Folgende Literatur wird empfohlen:
- Tanenbaum A. S.: Computer Netzwerke, Wolframs Verlag
- Killat U.: Entwurf und Analyse von Kommunikationssystemen, Vieweg+Teubner Verlag
- Krüger G., Reschke D.: Telematik, Fachbuchverlag Leipzig

Responsible for Module:
Kellerer, Wolfgang; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Kommunikationsnetze (Vorlesung mit integrierten Übungen, 4 SWS)
Kellerer W, Zerwas J
For further information in this module, please click campus.tum.de or here.

Catalogue of Elective Modules: Information Technology and Electronics (advanced) | Wahlkatalog: Informationstechnik und Elektronik (advanced)

Module Description

EI0622: Semiconductor Sensors | Halbleitersensoren

Version of module description: Gültig ab winterterm 2019/20

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

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

Description of Examination Method:
In a written closed book exam of 60 minutes duration questions and short calculations on physical foundations and principles as well as on structure, operation and application of semiconductor sensors have to be worked out in order to test if the student knows, has understood, can explain and apply them.
During the semester, there is the possibility to elaborate and give a voluntary seminar talk on a specific subtopic of the lecture. Provided a successful presentation, the grade can be improved according to the regulations of a mid term achievement.
The final grade is composed of
- 100% final exam
In case of a successfully passed seminar talk, the grade is lifted by 1/3 of an entire grade step.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
We recommend the successful participation in the following 4th semester module:
- Festkörper-, Halbleiter- und Bauelementephysik
The supplementary participation in Technical Mechanics is helpful.

Content:
-Introduction to technical and economical application fields of semiconductor sensors
-Physical foundations of the material properties used in semiconductor sensors, short overview on specific technological process (micromachining)

-Sensor principles and their concrete application to microsensor
The following topics are specifically addressed:
-Mechanical sensors (pressure, acceleration, angular rate), theory of elasticity, physical foundations of sensing effects (piezoresistive, piezoelectric, capacitive measurement principle)
-Contact temperature sensors: thermoresistors, diodes, transistors and their operations principle
-Radiation sensors: Bolometers, quantum detectors
-Magnetic field sensors: Hall sensors, field plates, AMR sensors
Optional: topics in the field of humidity sensing, smart sensor concepts and sensor systems

Intended Learning Outcomes:
By successfully completing the module, the students learn, understand and are able to explain the physicals foundations and principles of semiconductor sensors such as electro-mechanical, thermo-electric, magento-electric signal transduction, and they are able to apply this knowledge to simple, specific problems.
They understand the basic physical material and solid state properties of the materials used in semiconductor sensors and they know and can explain their relevance for the exploitation as sensor effect.
They know and are able to explain the realization of these principles in sensor concepts and their operation. They know exemplary application scenarios and fields of the presented sensors

Teaching and Learning Methods:
The content of the module is imparted by a lecture supported by Powerpoint slides and derivations and detailed explanation of physical-technical relations at the black board. During exercise hours the content of the lecture will be practiced and the understanding of it will be deepened by solving specific problems. During the seminar hour, individual students or small groups of students present specific and selected subtopics of the lecture to their colleagues (inverted classroom approach), which they elaborate on their own by given material and/or information on related literature. This effort will be honored by a bonus on the final grade according to the regulations of a midterm activity.

Media:
The lecture will be given by
- presentations with handouts, which are provided via Moodel
- Supporting material and detailed physical derivations are developped directly at the black boards
- Excercises with solutions are provided via Moodle

Reading List:
Further reading:
- W.Heywang; Sensorik, Springer Verlag, 1993
- J. Gardner: Microsensors, Wiley, 1994
- S. Senturia, Microsystem Design, Springer, 2001

Responsible for Module:
Schrag, Gabriele; Prof. Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Halbleitersensoren (Vorlesung mit integrierten Übungen, 4 SWS)
Schrag G, Seyfert L
For further information in this module, please click campus.tum.de or here.

Catalogue of Elective Modules: Power Engineering (advanced) | Wahlkatalog: Energietechnik (advanced)

Module Description

EI7328: Electromagnetic Compatibility in the Field of Power Engineering | Elektromagnetische Verträglichkeit in der Energietechnik

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
In einer Klausur (60 min) ohne Hilfsmittel weisen Studierende durch die Beantwortung von Fragen nach, dass sie die wesentlichen Kentnisse zur Umsetzung von EMV-gerechten Geräten und Analgen besitzen und geeignete Maßnahmen zur Blitzschutztechnik für vorgegebene Anwendungsfälle wiedergeben können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Keine speziellen Voraussetzungen erforderlich.

Content:
Einführung, Grundbegriffe und Definitionen. Beispiele für Störquellen. Koppelmechanismen, passive Schutz- und Entstörungskomponenten (Filter, Ableiter, Schirme). Maßnahmen zur EMV-gerechten Gestaltung von Geräten und Anlagen. Elektromagnetische Beeinflussung durch Blitzentladungen; Blitzschutztechnik. Spezielle EMV-Probleme in der Energie- und Automatisierungstechnik. Wirkung elektromagnetischer Felder auf Bioorganismen.

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung ist der Studierende in der Lage, die mögliche Wirkung von Störquellen und die Koppelmechanismen zu verstehen und diese Kenntnisse in geeignete Maßnahmen zur EMV-gerechten Gestaltung von Geräten und Anlagen umzusetzen. Weiter versteht er die Mechanismen, die zur Blitzentladung und infolge zu verschiedenen

Schädigungen führen und ist in der Lage, geeignete Maßnahmen zur Blitzschutztechnik umzusetzen.

Teaching and Learning Methods:
Als Lernmethode wird zusätzlich zu den individuellen Methoden des Studierenden eine vertiefende Wissensbildung durch Aufgabenrechnen in Übungen angestrebt.

Als Lehrmethode wird in der Vorlesungen Frontalunterricht, in den Übungen Arbeitsunterricht (Aufgaben rechnen) gehalten. Im Rahmen von Begehungen werden ergänzende Erläuterungen im Hochspannungslabor gegeben.

Media:
Folgende Medienformen finden Verwendung:
- Präsentationen
- Rechnerische und experimentelle Übungen

Reading List:
Folgende Literatur wird empfohlen:
- Schwab, A.J.: Elektromagnetische Verträglichkeit. Springer Verlag, 5. Auflage, 2007
- Heidler, F; Stimper, K.: Blitz und Blitzschutz. VDE-Schriftenreihe - Normen verständlich Band 128. VDE-Verlag Berlin.

Responsible for Module:
Koch, Myriam; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Elektromagnetische Verträglichkeit in der Energietechnik (Vorlesung mit integrierten Übungen, 4 SWS)
Hinterholzer T
For further information in this module, please click campus.tum.de or here.

Catalogue of Elective Modules: Computer Engineering | Wahlkatalog: Computer Engineering

Module Description

IN8024: Information Management for Digital Business Models | Informationsmanagement für Digitale Geschäftsmodelle

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
The examination consists of a 90 minutes written exam. In the exam, students shall verify without auxiliary means that they are able to understand the fundamentals of information management, apply methods for the determination of information needs, evaluate the quality of information, and analyze models and methods of IM. Furthermore, it is verified that they are able to apply methods for cost estimation, understand the role of "information" as a resource in companies, analyze the relationship between IT and business strategy, and evaluate existing business models and create new business models. Furthermore, students shall verify that they are able to address a given scientific problem independently in the field of information management by writing a term paper.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
None

Content:
The module “Information Management for Digital Business Models” covers the topics of management of information demand, supply, and usage, management of information systems (data, processes, application lifecycle), management of information and communication technology (storage, communication, processing, technology bundles), managerial functions of information management (IM organization, CIO, sourcing, business models, IM and strategy) and the role of information management in companies.

Intended Learning Outcomes:
At the end of the module "Information Management for Digital Business Models" students are able to understand the fundamentals of information management, apply methods for the determination of information needs, evaluate the quality of information, and analyze models and methods of IM. Furthermore, the students are able to apply methods for cost estimation, understand the role of "information" as a resource in companies, analyze the relationship between IT and business strategy, and evaluate existing business models and create new business models.

Teaching and Learning Methods:
The module consists of a lecture, an accompanying exercise and an empirical research part. Contents are taught in lecture and presentations. The Exercise addresses specific questions and exercises are completed in individual and/or group work with several learning activities including studying specialist literature and researching reference materials. The empirical research part includes participating and understanding empirical research projects as well as writing a scientific essay.

Media:
Overheads, PowerPoint, whiteboard, exercise sheets

Reading List:
Krcmar, Helmut. Informationsmanagement. 6. Aufl., Springer, 2015. ISBN: 978-3-662-45862-4

Laudon, Kenneth C., and Jane Price Laudon. Management information systems: Managing the digital firm. 15th edition, Pearson, 2017

Osterwalder, Alexander, and Yves Pigneur. Business model generation: A handbook for visionaries, game changers, and challengers. Vol. 1. John Wiley & Sons, 2010

Responsible for Module:
Großklags, Jens; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Information Management for Digital Business Models (IN8024) (Vorlesung mit integrierten Übungen, 4 SWS)
Großklags J [L], Chen M, Großklags J
For further information in this module, please click campus.tum.de or here.

Catalogue of Elective Modules: Computer Engineering (advanced) | Wahlkatalog: Computer Engineering (advanced)

Module Description

IN2073: Cloud Computing | Cloud Computing

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
The exam takes the form of an written 60 minutes test. Questions allow to asses acquaintance with the concepts of Cloud and Grid Computing. Questions describing usage scenarios and asking for the evaluation of the learned techniques in these scenarios are used to assess the ability to apply the learned techniques. In a discussion, their ability to solve research question is assessed.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge in computer architectures and distributed systems would be helpful.

Content:
The lecture starts with an introduction and a presentation of the base technologies for Cloud and Grid computing. The layered architecture of Grids and the base services are presented. Cloud Computing is then introduced and the different models SaaS, PaaS, IaaS. The list of base services is extended for Cloud Computing. The lecture also covers a discussion of legal issues.

Intended Learning Outcomes:
The students know the goals of Cloud and Grid computing. They can present application scenarios in different domains. They are familiar with the fundamental techniques in the areas security, application development and resource management. They can identify the differences and similarities between Cloud and Grid computing and distributed systems. They are able to participate in Cloud and Grid-related research projects.

Teaching and Learning Methods:
The concepts of Grid and Cloud Computing are introduced in the lecture. In the exercises, the student work on assignments that allow them to train the development of Cloud applications. References to current literature allow the students to deepen their understanding of the concepts.

Media:
Slides, Script, Exercise Sheets, Prepared Code Snippets.

Reading List:
- Berman, F., Fox, G., Hey, A. (ed.): Grid Computing-Making the Global Infrastructure a Reality, Wiley, Chichester 2003 (collection of 43 contributions, Grids and applications)
- Di Martino et.al. Engineering the Grid, American Scientific Publishers, 2004, (collection of 34 contributions to application and technology of grids)
- Furht, B., Escalante, A.: Handbook of Cloud Computing, Springer 2010
- Chorafas, D.: Cloud Computing Strategies, CRC Press 2011

Responsible for Module:
Gerndt, Hans Michael; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Cloud Computing (IN2073) (Vorlesung, 2 SWS)
Gerndt H (Jindal A)

Übung zu Cloud Computing (IN2073) (Übung, 1 SWS)
Gerndt H, Jindal A
For further information in this module, please click campus.tum.de or here.

Catalogue of Elective Modules: Industrial Engineering | Wahlkatalog: Industrial Engineering

Module Description

ED110106: Systems Engineering - Fundamentals | Systems Engineering - Grundlagen [SE-F]

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
The examination consists of a report, in which the students will summarise the project results, such as system architecture, requirements, model descriptions or other relevant materials to show their work.
The report is supplemented by a presentation between 5 and 10 minutes per group, where the project results are presented to the class. Each group member is required to present.

The grade is as follows:
Presentation - 25%
Report - 75%

The reports should be concise and written in a paper style, not exceeding 5 pages per student or 15 pages total. A template (LaTeX or Word) providing a formatting framework will be provided upon request, although no specific formatting guidelines exist. In addition, the students will be supplied with a list of questions hinting at the contents of the final report, instead of being given a sample structure, to allow students to choose a report structure appropriate to their project results. In case of group work, students are required to mark their individual contributions.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
1 Introduction to Systems Engineering and the SE Project
2 Introduction to Systems Architecture
3 Project Formulation
4 System Life Cycle Management
5 Operations
6 Trade-Offs and Complexity I
7 Trade-Offs and Complexity II
8 System Modeling I
9 System Modeling II
10 Risk Management
11 Project Management - Basics
12 System Verification and Validation

Intended Learning Outcomes:
On successful completion of this module, students should be able to:
LO 1 - Describe and discuss the main tools and processes of systems engineering
LO 2 - Identify the main project stakeholders and derive requirements from stakeholder needs
LO 3 - Conduct trade-off analyses and simple systems architecture studies during the early stages of a design project
LO 4 - Discuss system modelling techniques and apply selected techniques on engineering systems
LO 5 - Discuss and tailor a systems engineering approach to manage an engineering project across its lifecycle
LO 6 - Communicate effectively technical results to a large audience.
LO 7 - Cooperate as a team to achieve common goals.

Teaching and Learning Methods:
The module is divided into two complementary parts: Part 1 consists of a series of lectures and a systems engineering (SE) project, part 2 of exercises that explore concepts of the lecture and give aid in achieving the goals for the (SE) project.
In this module, students are given an overview over the most important concepts in Systems Engineering both as a scholarly field and in its real-life applications, starting from the main tools and processes of systems engineering and the identification of the main stakeholders and the derivation of requirements from stakeholder needs. The classes then detail the theory and practice behind conducting trade-off analyses and simple architecture studies on engineering systems as well as the application of modeling techniques and how to apply them to the system. To achieve this, the students are given the opportunity to apply those concepts and skills in an SE project, where SE tools are applied to an engineering system of choice. The entire chain of the systems engineering process is covered, with a focus on the classical early project phases and the management of engineering projects across their lifecycle. The distinction will also be made for a Systems Engineering process for a large organisation as well as more Agile methods more in use in early-stage start-ups. Understanding of techniques for these phases will be shown by completing the SE project.

Students will gain mastery of the following: Analysis of requirements–decomposition of system requirements to subsystems; introduction to project management and trade-space exploration as well as an introduction to modeling of systems and possible tools used.

As part of the SE project, the students will be organised in small groups, each group choosing an engineering system (e.g. space, automotive, aeronautical, …). The groups will then apply the SE knowledge to the analysis of the chosen system. For this, the students will be given a the choice between systems to work with and an choice of tasks related to the course material. A certain subset must be completed to finish the project successfull.

Examples may be:
- Comprehensively describe the system architecture and relevant interfaces;
- Perform a functional analysis of the chosen system and enumerate viable system alternatives and benchmark them compared to the baseline by proposing relevant and appropriate Figures of Merit (FOMs);
- Perform a stakeholder analysis for the chosen system;
To allow for student ideas in how to apply SE knowledge, the list may be extended – possibilities added to the list will be open to all students.

In addition, students can choose to submit a report (3-5 pages) on an additional topic to obtain a grade bonus of 0,3. This additional work is voluntary and, once completed, is applied until the next cycle where the class is held again.
They will be required to organise between themselves in each group to tackle all the needed specific tasks while ensuring that the overall work is complete.

Media:
Presentation (PowerPoint, Mentimeter, Kahoot!, ..)
Current Research Papers where applicable
E-Learning-Course (Moodle)

Reading List:
National Aeronautics and Space Administration, "NASA Systems Engineering Handbook". Washington DC, USA, 2017.

Responsible for Module:
Aliakbargolkar, Alessandro; Prof. Dr. phil.

Courses (Type of course, Weekly hours per semester), Instructor:
Systems Engineering - Fundamentals - Lecture (Vorlesung, 2 SWS)
Aliakbargolkar A [L], Aliakbargolkar A, Sindermann J, Messina V, Garcia Alarcia R

Systems Engineering - Fundamentals - Exercise (Übung, 2 SWS)
Sindermann J [L], Aliakbargolkar A, Sindermann J, Messina V, Garcia Alarcia R
For further information in this module, please click campus.tum.de or here.

Catalogue of Elective Modules: Sustainable Energies | Wahlkatalog: Sustainable Energies

Module Description

MW1476: Renewable Energy Technology 2 | Regenerative Energiesysteme 2 [RET II]

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
The exam takes 60 minutes and consists of a number of short questions on certain aspects of the topics presented as well as some calculations. Allowed auxiliary are writing and drawing utensils and a non programmable calculator.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic thermodynamics and fluid dynamics.

Content:
Content:
This course offers an insight into renewable energy sources, and the existing technologies to use them. It also looks to present the political framework of renewable energy technology, as well as societal and ecological aspects from a global point of view. The course is recommended for students not majoring in the field, who are interested in gaining an overview of renewable energy systems.
The course RENEWABLE ENERGY TECHNOLOGY (taught in English) is split into two modules 3 ECTS each (one per semester), beginning with “RET I” in the Winter Semester. The attached module “RET II” will be offered in the Summer Semester.
The course is supported by various institutions of the TUM: The Institute for Energy Systems, the Institute for Renewable and Sustainable Energies, The Institute for Wind Energy, The chair

of Hydraulic and Water Resources Engineering as well as the “Laboratory of Steam Boilers and Thermal Plants” from the National Technical University of Athens.

The module “RET I” covers the following topics:
• Fundamentals
• Energy from Biomass
• Geothermal Energy
• Wind Energy

In the module “RET II” the following topics are covered:
• Hydropower
• Solar Thermal Energy
• Photovoltaics

From the winter semester 2017/2018 onwards
the module "RET I" covers the following topics:
• Fundamentals
• Energy from Biomass
• Geothermal Energy
• Hydropower

whereas the module "RET II " is composed as follows:
• Wind Energy
• Solar Thermal Energy
• Photovoltaics

Intended Learning Outcomes:
After the participation in the module the students are able to understand the basics of the most relevant renewable energy technologies.
The gained knowledge enables the students to describe the fields of application as well as the limits of the presented renewable forms of energy. Moreover, the students are able to explain the elementary aspects of renewable energies from a physical, technical, and economical point of view.
They are familiar with technological solutions of all the presented renewable forms of energy and are able to classify their fields of application.
In addition, the students are able to identify the most suitable technology for a given field of application with particular focus on key physical, technical, and economical issues. In this context, the students are able to list and explain the environmental, economic, and social impacts of the selected technology.

Teaching and Learning Methods:
90 min lecture including discussion on the current topic per week. Students are encouraged to take part in the discussion and to question the arguments given by the lecturer. Autonomous preparing at home is needed to fully understand the learning matter.

Media:
Powerpoint presentations

Reading List:
German Literature:
Kaltschmitt, Martin: Erneuerbare Energien. Springer Verlag, Berlin

Quaschning, Volker: Regenerative Energiesysteme. Technologie - Berechnung - Simulation. Carl Hanser Verlag, München

Heliß, Michael: Regenerative Energiequellen. Praktikum. Springer Verlag, Berlin

Mohr, Markus: chancen erneuerbarer Energiequellen. Springer Verlag, Berlin

English Literature:
Spliethoff, Hartmut: Power Generation from Solid Fuels. Springer Verlag, Berlin

Boyle: Renewable Energy. Oxford University Press

Kaltschmitt, Martin: Renewable Energy: Technological Foundations, Economical and Environmental Aspects. Springer Verlag, Berlin

Wengenmayr, Roland: Renewable Energy: Soustainable Energy Concepts for the Future. Wiley-VCH Verlag

International energy Agency: Energy Technology Perspectives - Scenarios & Strategies to 2050

International Energy Agency: World Energy Outlook

Responsible for Module:
Spliethoff, Hartmut; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Regenerative Energiesysteme II (Vorlesung, 2 SWS)
Roeder G [L], Hamacher T, Bottasso C, Breuning L, Karellas S, Mörtenkötter H, Roeder G, Sucameli C
For further information in this module, please click campus.tum.de or here.

Other Electives in Management and/or Technology | Sonstige wirtschaftswissenschaftlich-technische Wahlmodule

Module Description

WI001181: Advanced International Experience | Advanced International Experience

Version of module description: Gültig ab summerterm 2021

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 180	**Contact Hours:** 0

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

Description of Examination Method:
Students have to pass a written single-choice exam. The module examination consists of a written 90-minute single-choice exam. The test examine deeper knowledge of the meaning of culture, cultural differences and resulting difficulties. Tasks which refer to scientific cultural concepts verify that students are able to distinguish between different cultural dimensions and standards, for example the cultural dimensions of Geert Hofstede's concept. Tasks which refer to different management styles and working cultures examine that students are able to analyse how different cultural backgrounds influence working in an international business context, for example a Western Management style. Tasks which refer to country-specific cultural differences proof that students are able to interpret critical intercultural situations correctly and offer adequate behavioral patterns. Tasks which refer to intercultural communication check that students are able to distinguish between different communication styles influenced by culture and know how to communicate adequately with members of different cultures, for example cultures with a direct communication style.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students have to complete a stay abroad relevant to their subject of studies before they can be admitted to the module. In general, for this purpose international study experience, practical training abroad as well as the completion of a project study or master's thesis is accepted. (Details see:https://www.mgt.tum.de/download-center)

Content:
This module gives an introduction to basic theoretical knowledge in scientific conceptualisation of culture, cultural differences and difficulties as well as their overcoming. During the module various scientific definitions of culture and different scientific approaches of cultural dimensions are outlined. By means of selected cultural characteristics and practical examples it is explained how to deal with different matters occurring when people with different cultural background interact. Additionally, different management styles in view of different cultures are declared. During the module explanatory approaches to difficulties which result from different cultural backgrounds in an international business environment are elaborated on. Further approaches how to overcome these difficulties are outlined by means of practical examples in a global working environment and in international teams. In addition, basic theoretical knowledge in communication and different models of communication are provided. Furthermore, it is defined how to deal with different communication styles of different cultures and how to communicate adequately in an international context. For this purpose, selected cultural characteristics and practical examples are used. Within the framework of the course students are asked to reflect, analyse and evaluate already experienced situations in view of the discussed theoretical models. Additionally, ethically relevant problem areas in international/intercultural businesses are outlined.

Intended Learning Outcomes:
After attending this module students are able to apply basic scientific approaches to culture and cultural differences. On basis of appropriate knowledge about cultural theories, particular cultures, as well as general knowledge about the issues occurring when people with different cultural backgrounds interact the students are able to analyse cultural differences and difficulties in an intercultural business context, as well as to interpret and overcome them. Additionally, students are aware of different communication styles in different cultures and know to apply this knowledge in intercultural communication situations. Furthermore, students will bear integrity, ethics and responsibility in mind when making management decisions in a multicultural business environment. Students are also able to reflect their experience abroad with scientific intercultural knowledge and develop an open-mindedness and sensitivity with respect to cultural differences.

Teaching and Learning Methods:
The module is created as an online-course. It is divided in various thematic areas which contain basic theoretical knowledge. In addition, practical examples, case studies and videos illustrate relevant concepts and their application in an international (business-) environment. Further exercises are provided at the end of each thematic area in order to encourage students to tackle with specific intercultural subjects and to develop kind of intercultural sensitivity. Additionally, a bibliography is prepared for students' self-study. Practice questions for exam preparation are also offered.

Media:
Digital Scripts (PowerPoint Slides, PDF files), scientific literature and exercise questions

Reading List:
Standard references (amongst others):

Hall, Edward T.; Hall, Mildred Reed (1990): Understanding Cultural Differences. Maine: Intercultural Press.
Hill, C.W.L. and Hernández-Requejo, W. (2011): Global Business Today, Seventh edition
Hofstede, Geert (2001): Culture's Consequences. Comparing Values, Behaviors, Institutions, and Organizations Across Nations. 2nd edit. Thousand Oaks: SAGE Publications Inc.
Thomas, Alexander; Kinast, Eva-Ulrike; Schroll-Machl, Sylia (Hg.) (2010): Handbook of Intercultural Communication and Cooper. Basics and Areas of Application : Volume 1: Basics and Areas of Application. 2nd revised edition. Göttingen, Berlin: Vandenhoeck & Ruprecht GmbH & Co. KG
Trompenaars, Fons; Hampden-Turner, Charles (2012): Riding the waves of culture. Understanding diversity in global business. Revised and updated 3rd edition. New York: Mc Graw Hill.

Responsible for Module:
Moog, Martin; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced International Experience (WI001181, WIHN1181) (Vorlesung, 4 SWS)
Richards M [L], Richards M, Zösmair S, Safieh M
For further information in this module, please click campus.tum.de or here.

Project Studies | Projektstudium

Module Description

WI900685: Project Studies (Master in Management and Technology) | Project Studies (Master in Management and Technology)

Version of module description: Gültig ab summerterm 2018

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

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

Description of Examination Method:
Grading is based on a project work. The project work consists of a written project report (20 pages, 50% of Grade) and of a final presentation (30 minutes, 50% of grade). A student team of at least 2 students works on a specific problem set within a company or any other similar institution. The team runs through several project stages: problem definition, division of work/tasks, decision making processes, and realization. In that the students show that they can develop appropriate strategies to cope the set of problems. They show that they are able to compose the state of research. In addition they demonstrate their ability to develop their own specific approach for a solution based on scientific knowledge as well as methodical skills. Students demonstrate their ability within a team to manage resources, and deadlines through timely submission of the enumerated tasks. Students demonstrate that they are able to complete the tasks of their project in a team environment. By presenting their project report students show their ability to summarize and communicate the evolvement of the project in a clear, well-structured and convincing manner to the supervisors from the company as well as the university. Additionally they show that they are able to respond competently to questions and discussions related to their suggested solutions brought by the audience.
Grading will especially take into account the overall working outcome of the project with respect to the initial problem set, the selection and application of the chosen methodology as well as the analyses and discussion of the main findings. The project work is set up in a way which enables the identification and evaluation of each student's individual contribution to the project's success.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in Business Administration

Content:
The project study consists of a specific problem statement or challenge which a company or any other similar institution is confronted with. This challenge may have a research related or practical character.
- Analyzing potential sales volumina of a new market,
- identifying potential optimization actions regarding a supply chain,
- creating a financing concept for a company,
- the explanation of problems out of the logistic sector and the development of appropriate optimization solutions,
- the development of specific Use-Cases for new electronic payment procedures and deduction of appropriate product specifications,
- the capturing and processing of KPIs in controlling and the development of recommended actions,
- or the development and explanation of a marketing strategy and the development of recommendations for implementing them in the given market- or company environment
are just a few examples of what may be subject of a project study. The project study and its findings regarding the outlined problem set are based on students' academic knowledge gained through their study programs.

Intended Learning Outcomes:
After successful participation in the module students are able work on a project in a systematic and academic manner. They can contribute an own part to a team's work output. Students are able to exchange in a professional and academic manner within a team. They show that they are able to integrate involved persons into the various tasks considering the group situation. Furthermore the students conduct solution processes through their constructive and conceptual acting in a team. They can make this contribution in a time limited environment. The students can capture and identify problem sets. Furthermore they can analyze appropriate methodologies for problem solving. They are able to infer the appropriate methodologies and to adapt these. On this basis they can develop analytical solution finding. Finally they can and evaluate the developed solutions regarding the problem set. Finally students are able to summarize and clearly and convincingly communicate the evolvement of their project and the developed solutions to an audience of professionals and academics.

Teaching and Learning Methods:
The team-based development (at least 2 students) of the project solution encourages the students to deal soundly with an academic or practical subject based on their previously acquired academic knowledge. Team work is particularly suitable for tackling problem sets and writing a report, for developing constructive critique to others and for implementing appropriate solutions to these critiques. The project may happen at the premises of the respective company/institution or from a remote location. They are able to communicate the evolvement of the project by composing a project report and preparing a presentation of their solutions to the supervisors from the company

as well as the university. The project is supervised jointly by mentors from the respective company/ institution and the professor of the TUM School of Management. With regards to content the project study takes an approximate time of three month.

Media:
literature, presentations

Reading List:
Project Management Institute (2013): A Guide to the Project Management Body of Knowledge (PMBOK® Guide) - Fifth Edition
Wilson, A. M., Jones, R., Miller, K., & Pentecost, R. (2009). Marketing research: An integrated approach. Pearson Australia.
Further specific literature based on the topic

Responsible for Module:
Pachur, Thorsten; Prof. Dr. phil.

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

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

Double Degree Program HEC Paris | Double Degree Program HEC Paris

Module Description

WI700006: Modules from HEC Paris | Modules from HEC Paris

Version of module description: Gültig ab summerterm 2019

Module Level: Master	**Language:** Language taught	**Duration:**	**Frequency:** winter/summer semester
Credits:* 60	**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:
Within this module courses of the double degree program with Grand École des Hautes Études Commerciales (HEC) can be recognized. If you are interested in the program, you can find more information here: https://www.wi.tum.de/student-life/joint-international-programs/.

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.

Master's Thesis | Master's Thesis

Module Description

WI900249: Master's Thesis (Master in Management and Technology) | Master's Thesis (Master in Management and Technology)

Version of module description: Gültig ab summerterm 2019

Module Level: Master	**Language:** German/English	**Duration:**	**Frequency:** winter/summer semester
Credits:* 30	**Total Hours:** 900	**Self-study Hours:** 900	**Contact Hours:**

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

Description of Examination Method:
The Master's Thesis is the final paper on a specific topic in business administration or economics. The thesis usually requires six months of work. Students describe and analyze the state of research on a specific topic. Based on the scientific knowledge and methodical skills acquired during their studies, students autonomously find an answer to their research question, or provide a solution to a specific problem. The Master's Thesis is supervised by a professor of the TUM School of Management or a professor who teaches on the program Master Management & Technology.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students can start their Thesis after the successful completion of at least 48 credits, of which at least 18 credits are from the technology specialization.

Content:
The Master's Thesis focuses on a research topic in business administration or economics, often with a special focus on engineering and natural sciences. The thesis is supervised by a professor of the TUM School of Management or a professor who teaches on the program Master Management & Technology, often in collaboration with a company or a research institution. The Thesis must be completed within six months.

Intended Learning Outcomes:
At the end of the module Master's Thesis, students are able to independently and systematically complete a scientific project. Therefore, students deploy their scientific knowledge and methodical

skills to the specific subject. They describe the state-of-the-art knowledge in the specific field, conduct the research, evaluate the findings, and classify them within the scientific and or practical discussion. So, students are able to independently address new and complex research questions and also develop their own solutions and recommendations.

Teaching and Learning Methods:
The thesis should familiarize students with scientific work and should give them deep insights into a specific topic. Therefore, students apply their knowledge and methodical skills, acquired during the studies, and create a scientific manuscript within the set time frame.

Media:
literature, presentations

Reading List:
specific literature based on the topic

Responsible for Module:
Fuchs, Christoph; Prof. Dr.

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

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

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