Module Catalog

M.Sc. Information Technologies for the Built Environment
TUM School of Engineering and Design
Technische Universität München

www.tum.de/
www.ed.tum.de/ed/startseite/

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 307

Required Modules | Pflichtmodule

Module Description

AR30472: Computational Design in Architecture | Computational Design in Architecture

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 30	**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 exam at the end of the semester (duration 60 minutes). The written exam at the end of the semester serves to test the basic theoretical principles of the lecture and transfer the knowledge of methods and tools in the planning process.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students must have a sound knowledge in design and planning methods, basic knowledge in digital methods and basic knowledge in using computers.

Content:
The module focuses on the exploration of digital tools for supporting the design and planning process in architecture and urban planning. The lecture provides theoretical knowledge and skills for the computer-aided design and planning process as well as data, BI & analytics strategies, evaluation methods, evaluation criteria and use cases for the implementation of key technologies, hardware and software solutions in the life cycle of constructions.

- Construction 4.0 - Key Technologies
- (semantic) contextual modelling - BIM and UIM in architecture and urban planning
- visual representations and documentation
- building survey
- parametric and generative modeling systems
- Big Data and AI in architecture and urban planning

- augmented and virtual reality
- digitally supported model making
- hardware and software interfaces
- data, BI & analytics strategies for the use of digital technologies in planning processes

Intended Learning Outcomes:
After participating the module course, the students are able to,
- understand the information technology landscape in architecture and urban planning,
- understand issues of social participation and information technology in architecture and urban planning,
- independently assess digital display and presentation options,
- independently assess complex software systems for design and planning support,
- integrate digital methods and tools into the design and planning process,
- independently conceptualize strategies for model data generation, structuring and transfer.

Teaching and Learning Methods:
The lecture content is taught by the chair’s staff and enriched by experts from the industry. The slides of the lectures, literature sources and other reference material are provided on the TUM learning platform. The students are encouraged to study the literature and to deal with the content of the topics.
To prepare for the exam, information on the application of the imparted contents in the planning process is provided for self-study and for the question session.

Media:
During the lecture, the contents are conveyed by means of presentations. The slides of the lectures, further literature sources and other template material will be made available on the TUM learning platform.

Reading List:
Teaching material will be made available on the Internet on a semester-by-semester basis

Responsible for Module:
Prof. Frank Petzold petzold@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Computational Design in Architecture (Vorlesung, 4 SWS)
Petzold F
For further information in this module, please click campus.tum.de or here.

Module Description

BGU48029: Introduction to Photogrammetry and Remote Sensing | Einführung in die Photogrammetrie und Fernerkundung [PRB]

Photogrammetry and Remote Sensing

Version of module description: Gültig ab summerterm 2020

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 written exam takes 60 minutes with content of Photogrammetry and Remote Sensing. Questions contain drawing and explaining figures, answering questions on methods and solutions, calculations or comparisons of methods and their applicability. Additionally, multiple-choice-questions are including with statements that have to be evaluated as true or false. This part does not contain more than 20% of the total points. No aids or materials are allowed.

Note in view of the limitations on university operations as a result of the CoViD19 pandemic: If the basic conditions (hygiene, physical distance rules, etc.) for a classroom-based examination cannot be met, the planned form of examination can be changed to a written or oral online examination in accordance with §13a APSO. The decision about this change will be announced as soon as possible, but at least 14 days before the date of the examination by the examiner after consultation with the board of examiners of the respective study program.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
Introduction: Definition Photogrammetry and Remote Sensing
- Characteristics of Photogrammetry, applications and development
- Characteristics of Remote Sensing, applications and development
- Introduction the Photogrammetry: stereoscopic vision and measurement, photogrammetric image analysis, digital stereo processing

- Introduction to Remote Sensing: Radiometric basics, multispectral classification
- Optical basics: models and geometric quality of optical projections, description of image quality

Intended Learning Outcomes:
Participants are capable to:
- Analyse applications from different points of view
- Planning aerial image campaigns
- Understand the principles of stereoscopic records
- Evaluate stereo records and produce anaglyphe images
- Understand concepts of photogrammetric image analysis
- Remember the physical basics of the electromagnetic spectrum and radiometric basics
- Understand the principles of supervised and unsupervised classification
- Apply different classifiers and evaluate the classification results
- Evaluate the influence of different factors on the image quality

Teaching and Learning Methods:
Lecture: Slides and lecture notes with small examples and discussion

Media:
Slides, lecture notes, program examples

Reading List:
"" Haralick, Shapiro (1992): Computer and Robot Vision (Vol. 1). Addison-Wesley, New York.
"" Castleman (1995): Digital Image Processing. Prentice Hall, Englewood Cliff, New Jersey.

Responsible for Module:
Christoph Holst

Courses (Type of course, Weekly hours per semester), Instructor:
PRE - Photogrammetry and Remote Sensing (Vorlesung, 2 SWS)
Wysocki O [L], Anders K
For further information in this module, please click campus.tum.de or here.

Module Description

BGU65016: BIM.fundamentals | BIM.fundamentals [BIM.fundamentals]

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
The learning outcomes of the module are assessed by means of a 60-minute written examination.

On the basis of the written examination, students demonstrate that they understand the theoretical concepts and methods of Building Information Modeling (BIM) they have learned and can recognize and reproduce common use cases. In knowledge and comprehension questions (e.g. on formulas, file formats, process steps), students demonstrate that they are able to use the concepts and methods they have learned to analyze and reflect on engineering problems in a structured manner.
No aids are allowed in the written exam.

The module grade can be improved on a voluntary basis via the completion of assignment sheets. Three assignment sheets are offered, of which the best two performances are included in the evaluation. A successfully completed and submitted assignment sheet will be awarded a maximum of 10 points.

The overall module grade is composed of the sum of the points achieved in the written exam (max 60 points) and the points achieved in the assignment sheets (max 2x 10 pts). To successfully pass the module, a total of at least 36 out of 80 possible points is required.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Students should have basic knowledge of digital design tools (CAD) and experience with building design and computational verification (e.g., Civil/Environmental Engineering BGU65011, Architecture AR20039, Geodesy BV470023 or equivalent).
Furthermore, a confident handling of the computer is helpful (Office applications, Internet, etc.).

Content:
• Introduction of digital technologies in construction
• Concept of Building Information Modeling (BIM)
• BIM definitions and terms
• BIM use cases
• BIM systems (authoring tools, inspection tools, data management)
• Computer-aided geometric modeling
• Parametric and procedural modeling
• Vendor-neutral data exchange formats
• BIM project workflow
• Process modeling
• Forms of collaborative cooperation
• BIM-GIS Integration

Intended Learning Outcomes:
After participating in the module courses, students will be able to,
• explain Building Information Modeling (BIM) in the planning process
• Identify potential problems of a BIM process chain and develop solutions
• Critically classify available commercial software for BIM-based planning
• Select digital analysis and simulation tools in a context-specific manner
• Relate BIM technologies to given case studies in terms of their technical foundations and outcomes.
• Understand the structure of BIM data formats
• evaluate different formats in terms of their intended use
• Use BIM data exchange mechanisms in a problem-specific manner

Teaching and Learning Methods:
The course consists of a lecture and an exercise. The lectures serve to convey the theoretical knowledge. In the tutorial, software examples are presented and the students are given the opportunity to deepen their knowledge on the computer by means of exercises. Tutors are available to support the exercises. In addition, there is the possibility of independent Work on lecture and exercise related assignment sheets outside of class time.

Media:
Lecture and exercise with PowerPoint presentation, blackboard writing and software examples on the computer.

Reading List:
Borrmann et al. Building Information Modeling Technology Foundations and Industry Practice. 2018
Eastman et al. BIM handbook: A guide to building information modeling for owners, managers, designers, engineers and contractors. 2011.

Responsible for Module:
André Borrmann

Courses (Type of course, Weekly hours per semester), Instructor:
BIM.fundamentals (Vorlesung, 2 SWS)
Borrmann A, Petzold F, Wu J, Memis I, Fellner J, Forth K

BIM.fundamentals Übung (Übung, 2 SWS)
Wu J, Memis I
For further information in this module, please click campus.tum.de or here.

Module Description

ED110044: Semantic Modelling of the Built World | Semantische Modellierung der gebauten Welt

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:** 105	**Contact Hours:** 75

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

Description of Examination Method:
The expected learning outcomes are verified by a written examination (120 minutes). Goal of the written examination is to assess that the students are able to understand and apply methods and technologies for modelling complex information from Geoinformatics, to analyze existing models and to create new models. Therefore, students have to analyze problems in a limited amount of time and to find and implement solutions based on the intended learning outcomes of the module. The answers partly consist of own formulations and drawings and partly consist of a choice from multiple options for answers. The students are not allowed to use any helping material.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Prerequisites are fundamentals in Informatics as coverd by the module "Introduction to Computer Science for Engineers 1".

Content:
In this course the students learn the methods and technologies for modelling complex geographic information, as they are nowadays used in the EU directive INSPIRE, in the official geo base data AFIS, ALKIS, ATKIS (AAA) and in semantic 3D city models (CityGML). Besides explaining the fundamental modelling concepts, the model-driven derivation of storage structures and data transfer formats is discussed in particular.
The exercises range from simple understanding of modern data models to the development of complex data models by the students themselves and the manual and automatic derivation of appropriate transfer formats for various fields of application.

The course focuses on the subject areas "structures and models for complex geo data", "Information models for the built environment", "storage and exchange of structured data", and "Semantic modeling of Built Facilities" which are structured as follows:

Information Modeling
- Advanced UML diagrams

Structures and models for complex geo data
- GIS standards for geographic information
- ISO 19107: Spatial Schema
- ISO 19109: Rules for Application Schema

Ontologies and semantic web
- Modelling of ontologies
- Ontology Web Language (OWL)
- Linked Data Concepts
- Resource Description Framework (RDF)
- Query Language SPARQL

Information models for the built environment
- CityGML: application schema for GML
- INSPIRE data modelling and encoding
- Building Topology Ontology
- Building Element Ontology

Storage and exchange of geo data
- Model Driven Architecture (MDA): from data models to transfer formats via the model-driven approach
- eXtensible Markup Language (XML) as generic storage and transfer format
- XML Schema Definition Language (XSD) as schema language for XML files
- Geography Markup Language (GML) and the development of GML application schemas as storage and transfer format for geo data
- JSON and BSON

Intended Learning Outcomes:
Upon successful completion of the module, students will be able to understand selected methods for semantic modeling of the built world, such as advanced UML diagrams, ISO standards 19107 (spatial schema) and 19109 (rules for application schemas), and Linked Data.
Students will be able to apply the Model-Driven Approach (MDA) to derive storage structures and data transfer formats from semantic models of the built world.
Furthermore, students are able to analyze existing data models, especially the international standards CityGML and IFC.
For specific use cases in the field of modeling of the built environment, students will be able to develop data models (conceptual schemas, ontologies) on their own.

Teaching and Learning Methods:
The course consists of two lectures with accompanying exercises.
The lectures serve the purpose of providing the theoretical foundations.
In the exercises the students are deepening the theoretical foundations by applying common software tools.

Media:
Moodle e-learning, presentations, scripts, specific software

Reading List:
Will be announced at the beginning of the course

Responsible for Module:
Kolbe, Thomas; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Semantic Modeling of Built Facilities (Vorlesung mit integrierten Übungen, 2 SWS)
Borrmann A [L], Borrmann A, Esser S, Schlenger J

Räumliche und semantische Modellierung der Umwelt (Vorlesung mit integrierten Übungen, 3 SWS)
Kolbe T (Heeramaglore M), Beil C, Fröch T
For further information in this module, please click campus.tum.de or here.

Module Description

ED110045: Geospatial Information Science | Geoinformationswissenschaft

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 examination consists of a written exam (120 minutes). Based on questions and given problems, the students have to prove that they are able to understand and apply spatial modeling and georeferencing of geospatial data, to explain different common types of geospatial data modeling and to perform them themselves, to understand, explain and comparatively evaluate presented methods for spatial analysis, to critically question the tasks dealt with in practical exercises in relation to the theory. No aids are allowed. Students have to answer questions about the understanding of spatial modeling, solve modeling tasks based on a given application example, examine incorrect examples based on the taught methods and algorithms, propose and justify suitable methods and algorithms for solving an application problem, and evaluate geoalgorithms with respect to their complexity. In addition, students must answer questions related to the approaches covered in the exercises.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Prerequisites are fundamentals in computer science as covered by the modules "Introduction to Computer Science 1 (BV470023)" and "Introduction to Computer Science 2 (BGU47029)"of the Bachelor program Geodesy and Geoinformation or "Computation in Civil and Environmental Engineering 1 (BGU65011)" and "Computation in Civil and Environmental Engineering 2 (BGU44019)" of the Bachor program Environmental Engineering.

Content:
'- General Data Modelling
- Spatial Modelling
- Topology

- Geometry
- Georeferencing
- Reference systems and Geoinformatics
- Spatial analysis and operations
- Spatial interpolation
- Geoinformation systems
- Geo Data Warehousing and Spatial Extract-Transform-Load (ETL)
- Introduction to Spatial Data Infrastructures
- Interoperability and data exchange

Intended Learning Outcomes:
After successfully completing the module, students will be able to,
- understand and apply spatial modeling and georeferencing of geodata
- explain and apply different, common types of geodata modeling
- understand, explain and comparatively evaluate presented methods for spatial analysis
- to critically question the tasks dealt with in practical exercises in relation to the theory.

Teaching and Learning Methods:
The module consists of lectures with integrated exercises. In the lectures, the theoretical foundations are taught. In the exercises, the concrete application of complex GIS software and geospatial data is practiced by the students solving given, subject-related problems. The exercises take place interactively at the PC and are carried out by lecturers with the support of student tutors. The exercises are solved by the students individually. The interactive work on the problems using relevant software is an important professional qualification and a prerequisite for successfully completing courses in subsequent semesters in which work is done with these systems.

Media:
Presentations, scripts, exercise sheets, GIS software, Moodle e-learning

Reading List:
Ralf Bill: Grundlagen der Geo-Informationssysteme, 6. Auflage, Wichmann Verlag, 2016
Paul A. Longley, Michael F. Goodchild, David J. Maguire, and David W. Rhind: Geographic Information Systems and Science, 4th edition, John Wiley & Sons, 2015
Mike Worboys, Matt Duckham: GIS: A Computing Perspective, 2nd edition, CRC Press, 2004

Responsible for Module:
Kolbe, Thomas; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Geoinformationswissenschaft (Vorlesung mit integrierten Übungen, 4 SWS)
Beil C, Knezevic M, Heeramaglore M, Kolbe T
For further information in this module, please click campus.tum.de or here.

Module Description

ED130001: Professional Software Engineering | Professional Software Engineering [ProSE]

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
The learning outcomes of the module are assessed by means of a written examination. The module grade can be improved on a voluntary basis via the completion of assignment sheets. In this case, the module grade is composed of 60% exam points and 40% of the points from assignment sheets. A total of 6 assignment sheets will be offered, of which the 4 pieces with the highest score will be included in the overall score. A successfully completed and submitted assignment sheet will be awarded with 0 - 10 points each.
A minimum of 45 points is required to successfully pass the module.

On the basis of the written examination, students demonstrate that they understand the theoretical concepts and methods learned about object-oriented programming and can solve simple engineering problems with suitable source code in a taught high-level language. In knowledge and comprehension questions (e.g. on common design structures or the consideration of different software architectures), students demonstrate that they are able to use the learned concepts and methods for structured analysis and reflection of engineering problems. No aids are allowed in the written exam.

The assignment sheets serve to enable the students to reflect on the individual topic blocks and finally to reproduce them in full. The solutions of the task sheets are worked out with the help of a computer. By means of this exercise performance, the acquired competences of a complex of topics from computer-aided engineering practice are to be checked. This will systematically test the understanding and specific skills of the basic tools of professional software development: The solutions are worked out in self-study and then uploaded to the Moodle learning platform, where the assessment of the submitted solution takes place. During the processing phase, tutors and the module supervisors are available to advise the students.

No aids are allowed in the exam.

Repeat Examination:

(Recommended) Prerequisites:
Elementary programming skills are required (e.g., Civil/Environmental Engineering BGU65011, Architecture AR20039, Geodesy BV470023 or equivalent).

Content:
- Learn professional software development practices using a high-level language
- Object-oriented programming based on UML models and design patterns
- Conversion of information represented in UML diagrams into program code using inheritances, interfaces and relationships
- Team development using repository services, automated unit testing, and source code documentation
- Implementation of data exchange interfaces using XML and JSON as well as connection to database systems

Intended Learning Outcomes:
After attending the course, students will be able to:
- describe higher-level principles of object-oriented programming with classes, inheritance, interfaces and relationships
- Outline selected design patterns of modern object-oriented programming.
- Apply principles of object-oriented programming to typical engineering problems
- Apply the concepts taught to given factual problems in a typical programming language.
- Implement data exchange interfaces based on XML and JSON as well as databases for the transfer of information between different components of software
- illustrate approaches of exception handling
- Implement concepts for software development in a team using version control services and unit testing

Teaching and Learning Methods:
The learning outcomes of this module are developed with several coordinated components. The integrated course consists of lecture and exercise components. Both parts are supported by PowerPoint presentations, blackboard writing, and code examples. Students have the opportunity to receive assistance with questions and problems in the exercise sheets through individual contact. The processing of the exercise sheets takes place outside of the attendance time.

Media:
Lectures and exercises: PowerPoint presentations, blackboard script and software examples on the computer.

Reading List:
Script with extensive literature references

Responsible for Module:
Prof. Dr.-Ing. André Borrmann

Courses (Type of course, Weekly hours per semester), Instructor:
Professional Software Engineering (Vorlesung, 3 SWS)
Berggold P, Carrara A, Du C

Professional Software Engineering Practical (Übung, 1 SWS)
Borrmann A, Berggold P, Carrara A, Pfitzner F
For further information in this module, please click campus.tum.de or here.

Module Description

ED130002: Distributed and Cloud-Based Systems | Distributed and Cloud-Based Systems [DistributedSystems]

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
The module exam consists of a written exam (120 min), which tests the students' knowledge in the area of distributed and cloud-based systems development. The students have to prove that they have understood the concepts of internet-based protocols and that they can apply them to given problems from the field of the built environment. In addition, you must demonstrate your understanding of distributed network architectures through independent programming efforts.
No aids are allowed in the exam.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Recommended prerequisites for successful participation are basics in computer science such as in the modules 'Civil and Environmental Informatics I (BGU65011)' and 'Civil and Environmental Informatics II (BGU44011)' or 'Introduction to Computer Science 1 (BV470023)' and 'Introduction to Computer Science 2 (BGU47029)' as well as geoinformatics such as in the module 'Geoinformation Science (ED110045)'.
Students should understand and be able to apply the basics of a programming language (data types, control structures, functions). In addition, an understanding of common software development methods, structuring of software projects as well as teamwork with reference to software, data security and time management is helpful, as taught e.g. in the Professional Software Engineering module.

Content:
• Introduction to distributed systems based on the ISO standard RM-ODP (Reference Model for Open Distributed Processing)
• Internet Protocol Stack

• Network architectures such as client-server, Peer2Peer or event-based systems
• Data transfer protocols
• Stateful vs. Stateless communication
• Implementation of REST-based function calls
• Concurrency control
• Virtualization and parallelization of computationally intensive procedures
• Cloud computing
• Spatial Data Infrastructures
• Selected concepts and technologies for security and access control in distributed systems, such as SSL/https, OAuth2 and OpenID Connect, Single-Sign-On

Intended Learning Outcomes:
After participating in the module courses, students will be able to:
- Describe basic concepts related to distributed or cloud-based systems in the context of the built environment
- explain principles of concurrency control and safety-related mechanisms
- Understand selected concepts and technologies for security and access control in distributed systems.
- Discuss advantages and disadvantages of different protocols for information transfer in distributed systems.
- Apply appropriate transfer protocols for selected use cases.
- outline network architectures for processing distributed data
- Apply various approaches to implementing interfaces and web services to given facts of the built environment.
- Develop interfaces for communication with various information systems via protocols such as http, ftp or websockets

Teaching and Learning Methods:
The learning outcomes of this module are developed with several coordinated components. The integrated course consists of lecture and exercise components. Both parts are supported by PowerPoint presentations, blackboard writing and code examples. Students have the opportunity to try out learned knowledge on the computer themselves. Tutors are available for support. The processing of the exercise sheets takes place outside of the attendance time.

Media:
Lecture and tutorial with PowerPoint presentation, blackboard writing and software examples on the computer.

Reading List:
Tanenbaum, A. S., Steen, M. v. (2016). Distributed Systems: Principles and Paradigms. Pearson Prentice Hall
Additional literature will be announced at the beginning of the course.

Responsible for Module:
André Borrmann

Courses (Type of course, Weekly hours per semester), Instructor:
Fundamentals of Distributed Computing (Vorlesung mit integrierten Übungen, 2 SWS)
Borrmann A, Esser S

Verteilte Geographische Informationsysteme und Cloud Computing (Vorlesung mit integrierten Übungen, 2 SWS)
Knezevic M, Kolbe T
For further information in this module, please click campus.tum.de or here.

Module Description

ED130003: ITBE Fusion Lab | ITBE Fusion Lab [FusionLab]

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 12	**Total Hours:** 360	**Self-study Hours:** 240	**Contact Hours:** 120

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

Description of Examination Method:
The certificate of achievement takes the form of a project work in a team, including the presentation of the project work. The topics of the project work are based on application-oriented problems of the built environment and include an information technology issue. They are determined taking into account the preferences of the students and are worked on by them independently in an interdisciplinary team.

The project includes the familiarization with the problem, if necessary a literature research as well as the choice and the implementation of the solution approach by using and developing software components. Partly, the software implementation includes the incorporation into already developed software modules or the connection to commercial software products.

The module grade consists of the evaluation of two interim presentations, a final¬ presentation, a scientific poster, the source code of the developed software as well as its written documentation and the evaluation of the communication and cooperation in the team. The progress of the project is documented in two presentations, in which the students present their results in groups. In addition, a final presentation will take place at the end of the project period, during which the poster will also be presented and its quality evaluated. Finally, the software projects and the documentation are evaluated. The weighting of the individual sub-grades is 10% for each interim presentation, 20% for the final presentation including the poster, 50% from the developed software and the documentation, and 10% for the communication and cooperation in the team. The amount of software development and documentation corresponds to 150 - 180 hours per student.

With the help of the presentations, it should be demonstrated that the students have understood the theoretical concepts underlying their project and can apply and evaluate them in a structured way to the problem (problem-solving skills). Furthermore, students should present progress at the beginning, middle, and end of their project, thus acquiring and demonstrating additional competencies in presentation skills. Checking the progress during the presentations motivates the methodological "soft" competencies of software development in several phases (e.g. agile methods).

The final presentation, including a poster and question and answer sessions at the end of the presentations, will test whether the students can present their results comprehensively and according to scientific standards. The processing by the students takes place independently outside of the attendance phase. In addition, during the development of the software, the students should show that they have understood basic and advanced programming concepts and can implement them.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Recommended prerequisite for successful participation are basics of engineering informatics as e.g. in the modules 'Civil and Environmental Informatics I (BGU65011)' and 'Civil and Environmental Informatics II (BGU44011)' or comparable. Students should understand and be able to apply basics of a programming language (data types, control structures, functions). In addition, an understanding of common methods of modern software development, teamwork in relation to software, data security and time management is helpful (such as the module BGU44013).

Content:
In this module, students work in interdisciplinary groups (3-4 students/group), on software projects at a scientific level. The goal of the assignment is to create software to solve a typical problem from the application area of the built environment and to apply the software tool to a concrete problem. The tasks are linked to the research-relevant fields of work of the participating chairs and can range, for example, from the processing of recorded sensor data using artificial intelligence methods to questions of additive manufacturing for the built environment. Additional input can also be generated by cooperations with industrial partners who can accompany the project work.

Intended Learning Outcomes:
After participating in the module courses, students will be able to:
• analyze information technology issues of the built environment and process them with the help of a self-developed program application-
• Present the development progress of a project as well as the knowledge gained therein in a clear manner to an audience outside the field and incorporate suggestions
• describe and document developed software according to common standards
• describe a software development process model (Waterfall, V-Model, Spiral, Agile, Scrum, XP, Kanban) and apply it in the team.
• to carry out a time planning in the development team and to make professional communication supported by software tools.

Teaching and Learning Methods:
The module consists of a seminar, which consists of group meetings with the supervisors and three lecture/presentation sessions including discussion. In the group meetings, the theoretical basics of the problem to be worked on are conveyed by the supervisors and reference is made to the relevant literature sources. Furthermore, the progress of the seminar is regularly checked together, if necessary new work packages are agreed upon and ambiguities are discussed. The implementation of the work packages is then carried out independently by the students outside the attendance phase. Students participate in the presentations both as presenters and as audience. They are required to communicate their progress in a clear and comprehensible manner and to engage in constructive discussions about the content presented.

Media:
• Video
• Presentations
• Poster
• Project descriptions

Reading List:
Sonmez, J. Z. (2015). Soft skills: The software developer's life manual.
Martin, R. C. (2014). Agile software development, principles, patterns, and practices. Pearson.
Bruegge B. (2010). Object-Oriented Software Engineering Using UML, Patterns, and Java, 3rd Edition.

Responsible for Module:
André Borrmann

Courses (Type of course, Weekly hours per semester), Instructor:
ITBE Fusion Lab Lectures (Vorlesung mit integrierten Übungen, 4 SWS)
Borrmann A, Mühlhaus S, Kolbe T, Nübel K, Petzold F, Esser S, Forth K, Vilgertshofer S

ITBE Fusion Lab Seminar (Seminar, 4 SWS)
Borrmann A, Mühlhaus S, Kolbe T, Nübel K, Petzold F, Esser S, Pfitzner F
For further information in this module, please click campus.tum.de or here.

Module Description

ED130018: System-Theoretical Principles of Project Management | Systemtheoretische Grundlagen des Projektmanagements [GL_PM]

Version of module description: Gültig ab winterterm 2022/23

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:
Supervised research paper (comprising analysis and elaboration of 8 – 10 lecture related topics) in which students are to prove their understanding of the learning content and their ability to apply the methods, evaluate the results and consequences, and moreover to develop the given approaches for further fields of utilization.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fundamentals of Process-oriented Planning and Organisation (GPPO BGU 55027)
Higher Mathematics, MATLAB

Content:
Projects and environment, fundamental definitions, 2nd order management, theory of systems, fundamental mechanisms of coordination, Cross-Impact-Analysis;
Factors of success, function, identification and interactions;
Process-oriented organisation of projects, models of proceeding, organisation structures and complexity;
Cost and resources in complex environments, cost-estimations and separability, expert knowledge, monitoring of cost;
Scheduling duration and target dates, theory of graphs, causal network plans, fuzzy networks, recent developments.

Intended Learning Outcomes:
Having successfully completed the module the students will have understood the given learning content and will be able to apply and develop this further. Therewith, they know to analyze and evaluate applicable situations and solve respective problems when later professionally working

Teaching and Learning Methods:
The learning content is taught via lectures. Supervised exercises and tutorials allow deepening this with the help of examples in interaction with the students.

Media:
Lecture notes, power point-presentations, partially use of black/whiteboard, videoclips

Reading List:
Detailed lecture notes

Responsible for Module:
Dr. Wolfgang Eber (eb@bv.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Systemtheoretische Grundlagen des Projektmanagements / System-Theoretical Principles of Project Management (Vorlesung, 2 SWS)
Eber W

Systemtheoretische Grundlagen des Projektmanagements / System-Theoretical Principles of Project Management (Vorlesung, 2 SWS)
Eber W [L], Eber W

Tutorium Systemtheoretische Grundlagen des Projektmanagements / Tutorial System-Theoretical Principles of Project Management (Übung, 2 SWS)
Eber W [L], Eber W

Tutorium Systemtheoretische Grundlagen des Projektmanagements / Tutorial System-Theoretical Principles of Project Management (Übung, 2 SWS)
Eber W [L], Eber W
For further information in this module, please click campus.tum.de or here.

Elective Modules | Wahlmodule

Ethics and the Human Factor | Ethics and the Human Factor

Module Description

BGU900010: Partner University - Elective Module | Partneruniversität - Wahlmodul

Version of module description: Gültig ab winterterm 2009/10

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

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

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

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

Module Description

BGU900011: Partner University - Elective Module | Partneruniversität - Wahlmodul

Version of module description: Gültig ab summerterm 2013

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

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

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

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

Module Description

BGU900012: Partner University - Elective Module | Partneruniversität - Wahlmodul

Version of module description: Gültig ab summerterm 2002

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

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

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

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

Module Description

ED0038: Technology, Economy, Society | Technik, Wirtschaft und Gesellschaft

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
The assessment consists of a written assignment (7800-8200 characters) which is due at the end of the semester. Students interpret research literature with respect to sociotechnical problems to analyze the development of technology in social, economic, and political contexts.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
The course does not require any special prior knowledge.

Content:
In this course, an approach to the political, economic, social and cultural dimensions of technology development is acquired. Selected historical and current examples will be analyzed to see how technical artifacts, processes and services emerge. Under which social conditions, in which economic situations and political contexts does technology emerge? How is it discussed, implemented, changed or discarded?

Intended Learning Outcomes:
Students will be able to identify examples of the historical dimensions of processes of technifikaction and to understand the emergence and use of technical offerings in their concrete historical context.

Teaching and Learning Methods:
Lecture, self-study, case studies, writing of smaller thematic papers.

Media:
electronic lecture notes, presentations

Reading List:
- Nelly Oudshoorn and Trevor Pinch (Eds.), How Users Matter. The Co-Construction of Users and Technology. Cambridge, Mass. 2005.
- Gernot Rieder, Judith Simon and Pak-Hang Wong, Mapping the Stony Road Towards Trustworthy AI, in: Pelillo, Marcello and Scantamburlo, Teresa (Eds.), Machines We Trust: Perspectives on Dependable AI. Cambridge, Mass. 2021, http://dx.doi.org/10.2139/ssrn.3717451 .
- Philip Scranton, Urgency, Uncertainty, and Innovation: Building Jet Engines in Postwar America, in: Management & Organizational History, 2006, 1:2, 127-157, https://doi.org/10.1177/1744935906064096.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Technology, Economy, and Society (Vorlesung, 2 SWS)
Reichenberger A
For further information in this module, please click campus.tum.de or here.

Module Description

CLA30210: Philosophy of Technology | Technikphilosophie

Version of module description: Gültig ab summerterm 2010

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

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

Description of Examination Method:
Im Rahmen einer Präsentation (30 min.) zeigen die Studierenden, dass sie in der Lage sind, auf Grundlage eines Textes ein technikphilosophisches Problem zu identifizieren und mit Bezug zum eigenen Fach sowie zu aktuellen Kontexten zu diskutieren (Prüfungsleistung 1). Durch Rekapitulationen (Zusammenfassung von Präsentation und Diskussionen) zeigen die Studierenden, dass sie Diskussionen nachvollziehen und dazu beitragen können (Prüfungsleistung 2).

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Technikphilosophie fragt nach dem, was Technik ist, wie technische Gebilde entstehen können und welche Folgen deren Verwendung hat. Das Modul bietet eine Einführung in folgende Themenfelder:
1. Mensch - Technik - Natur
2. Wissenschaft und Technik
3. Kultur der Technik
4. Technik und Ethik

Intended Learning Outcomes:
Die Teilnehmer sind in der Lage, philosophische Probleme der Technik zu verstehen und einen Text insbesondere auf den implizierten Technikbegriff hin zu analysieren. Zudem verfügen sie über Erfahrungen in der interdisziplinären Vermittlung und Reflexion fachspezifischen Wissens. Sie

sind zudem in der Lage an Diskussionen zu technikphilosophischen Problemen in mündlicher und schriftlicher Form beizutragen und wesentliche Punkte darzustellen.

Teaching and Learning Methods:
Textbasiertes Seminar, Referate, Diskussionen, Gruppenarbeit, Selbststudium insbes. Lektüre/ Erarbeitung von Texten, Online-Forum

Media:

Reading List:

Responsible for Module:
Fred Slanitz

Courses (Type of course, Weekly hours per semester), Instructor:
Technikphilosophie - Texte zur Einführung (Seminar, 2 SWS)
Slanitz A
For further information in this module, please click campus.tum.de or here.

Module Description

CLA30230: Ethics and Responsibility | Ethik und Verantwortung

Version of module description: Gültig ab winterterm 2010/11

Module Level: Bachelor/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:
Das Modul wird mit einer wissenschaftlichen Ausarbeitung in Form eines Essays (4000-5000 Zeichen) abgeschlossen. In diesem dokumentieren die Studierenden, dass sie ethische Argumente differenziert zuordnen und i.S. von Handlungspositionen konzeptionell umsetzen, sowie sprachlich verständlich darstellen können.
In Vorbereitung der schriftl. Ausarbeitung zeigen die Studierenden in einem Referat (25-35 min), dass sie in der Lage sind, eine Methode ethischer Urteilsbildung für mögliche Konfliktszenarien in den Problemfeldern Wissenschaft und Technik darstellen können (Gewichtung 7:3).

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Wir treffen täglich Entscheidungen. Dabei spielen Fakten eine große Rolle, oft aber auch das sogenannte Bauchgefühl. In gesellschaftlichen Debatten um brisante Anwendungen von Wissenschaft und Technik kommt viel darauf an, beides voneinander zu unterscheiden und vor allem gute Gründe pro oder contra zu finden. Ethik leitet dazu an, mit Konflikten verantwortlich umzugehen. Aber welche Art von „Wissen“ wird dabei eingesetzt? Wie verhalten sich Recht und Ethik zueinander? Und wie lässt sich über angewandte Ethik sprechen, ohne Moral zu predigen?

Intended Learning Outcomes:
Die Studierenden sind in der Lage mithilfe einer Methode ethischer Urteilsbildung exemplarische Konfliktszenarien auf den Problemfeldern von Wissenschaft und Technik zu beschreiben und abzuschätzen. Nach der Teilnahme am Seminar sind sie in der Lage, ethische Argumente im Hinblick auf ihre Geltungsansprüche zu unterscheiden und verantwortliche Handlungsoptionen

in verständlicher und zugleich anwendungsnaher Sprache für ein ethisches Gutachten reflektiert aufzubereiten.

Teaching and Learning Methods:
Präsentation, Referat, Diskussion, Textanalyse

Media:

Reading List:
Fritz Allhoff, What Are Applied Ethics? http://files.allhoff.org/research/What_Are_Applied_Ethics.pdf
Lee Archie, John G. Archie, Introduction to Ethical Studies An Open Source Reader, https://philosophy.lander.edu/ethics/ethicsbook.pdf
John Deigh, An Introduction to Ethics, http://dx.doi.org/10.1017/CBO9780511750519.002

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Ethics of Technology (Vorlesung, 2 SWS)
Campos Sasdelli D

Ethics of Responsibility: An Introduction to Applied Ethics (Core Topic MA STS) (Seminar, 2 SWS)
Wernecke J
For further information in this module, please click campus.tum.de or here.

Module Description

CLA30420: Integration of Technology into Society | Integration of Technology into Society

Version of module description: Gültig ab winterterm 2014/15

Module Level: Bachelor/Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 69	**Contact Hours:** 21

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

Description of Examination Method:

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Angesichts des rasanten Fortschritts in Digitalisierung, Robotik oder Biotechnologie stellt sich mehr denn je die Frage, wie Technologien unser Erleben, Denken und Handeln verändern und Grenzen verschieben. Wie beeinflussen Maschinenlernen und Big Data unser Verständnis von Privatheit? Inwiefern berühren Pränataldiagnostik und synthetische Biologie unsere tradierten sozialen Normen und Werte? Wer trägt Verantwortung für autonome Systeme? Und wie dürfen wir uns ihnen gegenüber verhalten?

Anhand von aktuellen Technologien werden soziale, politische, rechtliche und ethische Probleme identifiziert, mittels sozial- und geisteswissenschaftlicher Konzepte reflektiert und Positionen aktueller Debatten diskutiert.

Intended Learning Outcomes:
Die Teilnehmer sind in der Lage, exemplarisch soziale, politische, rechtliche oder ethische Probleme der gesellschaftlichen Integration von Technologien zu identifizieren, mittels sozial- oder geisteswissenschaftlicher Konzepte zu analysieren und für eine Position hinsichtlich möglicher Konsequenzen zu argumentieren.

Teaching and Learning Methods:
Dozenteninput, Präsentationen, Diskussionen, eigenständige Lektüre

Media:

Reading List:

Responsible for Module:
Fred Slanitz

Courses (Type of course, Weekly hours per semester), Instructor:
MA-Spezielle Soziologie: Soziologie der Krise (Seminar, 2 SWS)
Beck S, Schönbauer S

Can Machines Decide Legal Cases? An Introduction to the Logic of Norms and to Theoretical Legal Informatics (Vorlesung, 2 SWS)
Campos Sasdelli D

Moralische Bots? - Ethische Herausforderungen von autonomen Maschinen und sprechenden Computern (Seminar, 1,5 SWS)
Slanitz A, Tremmel S
For further information in this module, please click campus.tum.de or here.

Module Description

CLA31601: Ethics and Responsibility II | Ethik und Verantwortung II

Version of module description: Gültig ab summerterm 2018

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 3	**Total Hours:** 60	**Self-study Hours:** 45	**Contact Hours:** 15

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

Description of Examination Method:
Das Modul wird mit einer Modulprüfung in Form eines Essays (1000-1500 Wörter) abgeschlossen, in dem die Studierenden dokumentieren, dass sie die wichtigsten Argumente eines Bereichs der angewandten Ethik verstanden haben und auf ein aktuelles Foschungsfeld übertragen können. Im Sinne einer Vorbereitung zur Modulprüfung erstellen die Studierenden eine Präsentation (Umfang 25-35 Min.), in der ein Anwendungsfeld und dessen ethische Bewertung erarbeitet und vorgestellt wird.

Repeat Examination:

(Recommended) Prerequisites:
Fortgeschrittene Studierende.
Erfolgreiche Teilnahme an einer einführenden Ethikveranstaltung.

Content:
Vertiefte Behandlung von Themen aus den Bereichen Umweltethik, Wissenschaftsethik, Technikethik, Medizinethik oder Informations-/Medienethik in philosophischer Perspektive unter Berücksichtigung aktueller Forschungsfelder.

Intended Learning Outcomes:
Nach der Teilnahme sind die Studierenden in der Lage die wichtigsten Argumente eines Bereichs der Angewandten Ethik zu verstehen und in andere Kontexte zu übertragen. Sie kennen den aktuellen Stand der Diskussion und können eine eigene Position schriftlich formulieren und argumentativ begründen.

Teaching and Learning Methods:
Textanalyse, Webplattform, Diskussion, Präsentation, Referat

Media:

Reading List:

Responsible for Module:
Dr. rer nat. Eva Sandmann

Courses (Type of course, Weekly hours per semester), Instructor:
Project Seminar Applied Ethics (Seminar, 3 SWS)
Sandmann E, Wernecke J

Project Seminar: Applied Ethics of Responsibility - Wildlife Management and Conservation (Seminar, 2 SWS)
Sandmann E, Wernecke J

Mensch – Maschine: Von Automaten, Robots und Moral Machines (Seminar, 2 SWS)
Wernecke J

Ethics of Responsibility: Current Areas of Application (Seminar, 2 SWS)
Wernecke J
For further information in this module, please click campus.tum.de or here.

Module Description

ED130090: Participatory Design | Partizipatives Design [Participatory Design]

Version of module description: Gültig ab summerterm 2024

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

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

Description of Examination Method:
The final examination of the module consists of the following two components:
(Please note: These exam modalities only apply to students who only take the seminar, but do not participate in the project. If you participate in the project, the exam for the seminar is built into the exam modalities as described in that module description.)

(1) In-Classroom Intervention (group-based) (50%)
During this course, students will design and conduct a small-scale intervention in the classroom, creating a scenario in which students test one of the Participatory Design methods they have learned in class (on each other). Your intervention will need to demonstrate that you have developed the ability to choose the right method for a particular context, to design the intervention itself, to facilitate a participatory intervention, and to co-evaluate the intervention itself together with the students who were part of the intervention.

(Re-enact example from the paper, come up with imaginary scenario, or design an intervention related to the adjacent project)

(2) Documentation (50%): The documentation of the learning journey includes core concepts and methods you have learned during this course. It will be framed as an empirical study, resembling a scientific paper, of the Participatory Design interventions you have designed during this module (instruction for how to write such a paper is part of the course). You should include references to the course readings and other scientific sources.

The total word count is min 1,200 and max 1,500 words excluding sources; A4 format; you may choose the font and visual style that best represents your work. You may include visuals (images, diagrams) as you see fit.

Repeat Examination:

(Recommended) Prerequisites:
Fluency in English; interest in Participatory Design; willingness to work in a team

Content:
Participatory Design is an approach that has been gaining attention over the last decades, as it promises a collaborative process with participants, where insights and designs are created through an iterative process during which design decisions are jointly made and power is shared. It stems from Participatory Action Research and has the goal of improving the quality of life for the participants of the process. It has gained traction both in the research community as well as with design practitioners as it questions the role of the researcher/designer, and aims to establish equitable practices of value creation.

There is a plethora of methods used in Participatory Design, ranging from short-term interventions to large-scale transformational experience design. These will be explored, mapped and evaluated based on their applicability. Methods to be tested in the classroom with peers will include low-cost prototyping methods, ethnographic methods, collaborative mapping, community-based co-design and digital storytelling. We will make enough time for you to explore a wide variety of opportunities of the use of Participatory Design before settling on the method you will test.

By the end of the semester, you should have acquired both an understanding of Participatory Design as a method, the ability to use this method, as well as a keen understanding of the complexities that come with it and sometimes limit its use.

Note: in the 2024 summer term, the Participatory Design seminar is part of a project module, "Designing Experiences: Von Strategie zum Prototyp. Sonderthema: Reaktivierung Heizkraftwerk". Students who participate in the project module will use Participatory Design methods in the applied scenario of their project. This also allows students who only participate in the seminar to gain insight into such applications.

However, attending the Participatory Design seminar does not require students to also sign up for the project.

Intended Learning Outcomes:
After successful completion of this module, students will be able to:

● plan and conduct participatory design interventions on a small scale (in classroom), experimenting with and utilizing a variety of Participatory Design methods
● evaluate and reflect upon their choice of method and its appropriateness (based on the personalities of the facilitators, hypothesis, data collection, context of the intervention and participants)

● engage with real-world problems using a wide range of Participatory Design methods going forward
● maintain a critical lens on research ethics and best practices in participatory design
● collaborate in multidisciplinary teams

Teaching and Learning Methods:
This module conveys content through a combination of literature, discussions, and the practical application of learnings:
You will acquire foundational theoretical knowledge through assigned readings as well as short lectures, laying the groundwork for practical interventions. You will then have the opportunity to apply your newfound knowledge through the development of an in-class intervention of Participatory Design, trying out how to create an experience for your peers that will alllow you to gather valuable input while simultaneously ensuring that your participants feel heard and can influence decision making. Thus, theory will be accompanied by engagement in facilitation practices, allowing both for facilitation and experiencing of different methods.

We will start from the big picture, inlcuding the background of Participatory Design, its motivations, and how large-scale Participatory Design is conducted by researchers over longer periods of time. We will also discuss how the method is being understood and used by design practicioners. An analysis of papers and cases will help frame a conversation about the limitations and ethical considerations of Participatory Design. You will also gain an overview of specific methods.

You will then co-create a plan for a large-scale Participatory Design project. Based on this, you will then plan a small-scale Participatory Design intervention, which takes place with fellow students within the frameworks of the class. You will learn to actively construct your own “models” of contexts and situations to decide what to do about a particular problem. Finally, a reflection and evaluation of the work takes place, which informs the final report.

When appropriate, guest speakers are invited to illustrate Participatory Design in its application beyond academia.

Media:
Presentations, videos, guest lecturers, whiteboards, post-its, templates, some basic prototyping materials.

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

Responsible for Module:
Prof. Annette Diefenthaler

Courses (Type of course, Weekly hours per semester), Instructor:
Partizipatives Design (Seminar, 2 SWS)
Diefenthaler A [L], Diefenthaler A, Löhe T, Sipos R

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

Module Description

ED150036: Ethical Robot Systems | Ethische Robotersysteme [EROS]

Version of module description: Gültig ab summerterm 2024

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 module examination takes the form of a written exam (duration 90 min, permitted aids: calculator). The basics of ethics in robotics are tested on the basis of short questions. Using comprehension questions and transfer questions, the participants show, for example, that they have understood the individual ethical issues, can analyse real measurement data and can analyse the ethical behaviour of robots.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The basics of robotics are recommended as prerequisites, but are not absolutely necessary to understand the content.

Content:
The lecture "Ethical Robot Systems" provides a comprehensive overview of the intersection of ethics and robotics. This field is becoming increasingly important as robots and artificial intelligence (AI) permeate more and more areas of our lives. In this course, students will learn the fundamental concepts of robotics and ethics, focusing on the challenges of integrating ethical principles into developing and using robotic technologies. Students will explore the moral issues raised by autonomous systems, data protection, surveillance, the impact of robotics on the world of work, human-robot interactions, and issues of responsibility and liability.
In the lecture, students develop the ability to apply ethical theories to concrete problems, design and evaluate ethical decision-making processes for technological developments, and analyze the long-term impact of robotic technologies on society and individual lifestyles. In a focussed part of the lecture "Ethical Robot Systems", students are confronted with the ethical challenges in software development and AI, especially about bias and moral decision-making. They deal with the emergence of bias through faulty data or algorithms and learn methods to recognize and

minimize it. The discussion also includes how ethical principles such as fairness, transparency, and responsibility can be integrated into the development of AI systems. The goal is to prepare students to create ethically responsible technologies that enhance user trust and promote socially positive impact.
Through discussion of case studies and current research, students will be encouraged to think about and critically reflect on the social and ethical implications of advancing technologies. The course also addresses how ethical considerations can be integrated into the development process of robotics and AI to create technologies that respect societal values and norms.

Intended Learning Outcomes:
After participating in the module, students will have a deep insight into the basic contexts of machine ethics with special application to robotic systems. After the lecture, students will be able to understand and explain the basic concepts and challenges at the interface of ethics and robotics. This enables students to apply and critically analyse ethical theories to real-world problems and case studies in robotics. Furthermore, students will be able to continuously reflect on the methods and knowledge they have learnt with regard to sustainable ecological, social and economic development. After the lecture, students will be able to design and evaluate ethical decision-making processes for the development and implementation of robot technologies. In addition, students will be able to identify and discuss future technological developments in robotics and their potential ethical challenges. One focus here is the inclusion of context-dependent and individual perceptions of sustainability. As the module is open to different disciplines and raises transdisciplinary questions, students are able to understand the language of others, justify their own decisions and convince others with arguments in teams from their own discipline, but also in interdisciplinary teams.

Teaching and Learning Methods:
In the lecture, the course content is conveyed by means of a lecture and presentation (Power Point). More complex issues are derived and illustrated using a tablet PC. During the lecture, explicit questions are asked that require students to transfer their knowledge and where students are given the opportunity to speak up and discuss a possible solution. In this way, the challenging tasks of robotics will be deepened and the transfer to various robot applications (e.g. robots in agriculture) will be achieved.
Simple but critical situational examples that have to be solved by robots are also explained in the lecture. These example tasks can be actively solved by the students. These examples are primarily in the area of road vehicles (e.g. road intersection in the city centre), which enables students to subsequently analyse and evaluate further problems of other autonomous systems (e.g. robots in agriculture). A weekly consultation hour is offered to answer questions about the individual appointments and homework, which can be attended in person or online (appointment announced via Moodle).

Media:
Lecture, presentations, discussion, tablet PC and projector

Reading List:
Pendleton et. al, Perception, Planning, Control, and Coordination for Autonomous Vehicles, Machines 2017, 5(1), 6; https://doi.org/10.3390/machines5010006
Book: "Robot Ethics: The Ethical and Social Implications of Robotics" by Patrick Lin, Keith Abney, and George A. Bekey
Book: "Moral Machines: Teaching Robots Right from Wrong" by Wendell Wallach and Colin Allen
Paper: "Ethics of Artificial Intelligence and Robotics" by Vincent C. Müller in Stanford Encyclopedia of Philosophy

Responsible for Module:
Prof. Dr. Johannes Betz

Courses (Type of course, Weekly hours per semester), Instructor:
Ethical Robot Systems (Vorlesung, 2 SWS)
Betz J [L], Betz J
For further information in this module, please click campus.tum.de or here.

Module Description

MW2130: Software Ergonomics | Software-Ergonomie [Software-Ergonomics]

Version of module description: Gültig ab summerterm 2024

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:
The examination comprises a written exam with a duration of 60 minutes and four seminar papers done as homework during the semester. The overall grade is calculated from the single grades at a ratio of 2:1 (written exam:seminar papers). In addition to the theoretical basics, which are tested in the written exam, students should also apply their knowledge in practice by designing and evaluating an application themselves in groups of 4-5 students in the exercise. This process is documented in the four homework assignments (total length approx. 10-15 pages per group).
The written exam at the end of the semester assesses the students' understanding of basic principles for the design of usable software. The students proof that they are able to identify problems in the field of usability engineering and that they can solve them within limited time by applying appropriate methods. A non-programmable calculator is allowed to use.
Within the seminar's tutorials, students work on a project in which they get to know all stages of the user-centered design process. They proof that they are capable of planning and managing the design process and that they are able to conduct a usability evaluation. For examination, four seminar papers must be prepared during the semester.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
A former visit of the lecture "Ergonomics" is recommended, but not mandatory.

Content:
Software suffers - like no other product - from the users' requirement of being easily and safely handled. Software products that are difficult and uncomfortable to use, will not be accepted by the user.

The aim of the course is to get in touch with ergonomic principles for the design of software to ensure accurate and user-friendly software experience. These principles include basic knowledge about the process of human information perception and processing, principles governing the design of graphical user interfaces, as well as planning and implementing evaluation methods. Within the tutorial, methods for developing usable graphical user interfaces are taught. These methods include general development processes (e.g. user-centered design), methods for user analysis as well as standardized methods for the evaluation of prototypes and final products.

Intended Learning Outcomes:
At the end of the seminar, students are able to
- understand the processes of human information processing (perception, response selection, response execution),
- remember usability design rules,
- remember relevant standards of software design,
- analyze software in terms of usability design principles,
- understand the involvement of usability engineers in the software development,
- understand the internationalization approach for graphical user interfaces,
- planning and managing a user centered design process including an evaluation of results.

Teaching and Learning Methods:
The lecture is done as presentation. For further learning and additional information we recommend literature, which is quoted in the lecture notes. Within the tutorial, participants work in groups on a project in which the content of the lecture is deepend practically. On the basis of practical examples, the whole process of user-centered design is undergone. For this purpose, participants choose a topic, which can be any kind of software or app which has to be developed. Then, within the project, a graphical user interface for the software or app is designed.

Media:
Powerpoint presentations, literature in a library with free access.

Reading List:
Further reading is included in the lecture notes, e.g.
1. Bangor, A., Kortum, P., & Miller, J. (2009). Determining what individual SUS scores mean: Adding an adjective rating scale. Journal of usability studies, 4(3), 114-123.
2. Christoforakos, L., Diefenbach, S., Kohler, K. & Tretter, S., (2018). Effektives Prototyping: Eine Stakeholder-orientierte Perspektive. In: Hess, S. & Fischer, H.
(Hrsg.), Mensch und Computer 2018 - Usability Professionals. Bonn: Gesellschaft für Informatik e.V. Und German UPA e.V.. (S. 103-114). DOI:
10.18420/muc2018-up-0171

Responsible for Module:
Elena Malaika von Dewitz

Courses (Type of course, Weekly hours per semester), Instructor:
Software-Ergonomie (Vorlesung, 2 SWS)
von Dewitz E [L], Bengler K, Emmermann B, Herzog O

Software-Ergonomie Übung (Übung, 1 SWS)
von Dewitz E [L], Bengler K, Emmermann B, Herzog O, von Dewitz E
For further information in this module, please click campus.tum.de or here.

Module Description

MW2131: Human Reliability | Menschliche Zuverlässigkeit [Human Reliability]

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
The examination consists of a written exam (90 minutes), where students should remember the content of the course without supplementary materials. In the exam, students are expected to e.g. apply calculation methods on given examples, analyze given case studies, evaluate design approaches and describe technical terms.

Current note in view of the restricted presence operation due to the CoViD19 pandemic:
If the general conditions (hygiene, distance rules, etc.) for a face-to-face examination are not available, the planned examination form can be changed to electronic remote examination according to §13a APSO. The decision on this change will be announced as soon as possible, but no later than 14 days before the examination date by the examiner after consultation with the responsible examination board.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
We recommend a previous attendance in human factors lectures (e.g. Arbeitswissenschaft/ Ergonomics).

Content:
In socio-technical systems humans are a frequent assumed source of errors, described as human error as a term for deviations from a target value up to desasters. This lecutre explains the relationship between the human factor and technical reliability.
Additionally, models explaining and classifying human performance and errors are discussed and applied in case studies. Moreover, methods of risk assessment and risk mitigation are discussed. These models and methods are necessary elements for resilient system design. All models and

methods are supported by given examples from different technical domains. A presentation of relevant ergonomic standards and norms as well as the standardization process itself provides the student an insight into industrial guidelines and regulations.

Intended Learning Outcomes:
At the end of the module students are able to
- analyze mechanisms of human behavior and to apply these in the context of reliability estimation
- classify human errors and to apply the models given by literature
- analyze risk and evaluate mitigation strategies
- apply design rules and guidelines for resilient system design
- name relevant standards and norms

Teaching and Learning Methods:
The course is based on a presentation with case studies and practical applications.
In the exercise, the content of the lecture is deepened. The exercise is designed as a tutorial. The cited literature is recommended.

Media:
Powerpoint presentations, written literature in the form of scientific publications

Reading List:
Bubb, Heiner; Albers, Stephan (1992): Menschliche Zuverlässigkeit. Definitionen, Zusammenhänge, Bewertung. 1. Aufl. Landsberg/Lech: ecomed.

Further and specific literature on the individual course dates is referred to in the lecture notes.

Responsible for Module:
Bengler, Klaus; Prof. Dr. phil.

Courses (Type of course, Weekly hours per semester), Instructor:
Menschliche Zuverlässigkeit (MW2131) (Vorlesung, 2 SWS)
Prinz T [L], Bengler K (Prinz T), Prinz T

Menschliche Zuverlässigkeit Übung (Übung, 1 SWS)
Prinz T [L], Bengler K (Prinz T), Prinz T
For further information in this module, please click campus.tum.de or here.

Module Description

MW2272: Interaction Prototyping (Practical Course) | Interaction Prototyping (Practical Course) [IPP]

Version of module description: Gültig ab summerterm 2018

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 4	**Total Hours:** 140	**Self-study Hours:** 95	**Contact Hours:** 45

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

Description of Examination Method:
As an outcome of the Interaction Programming Block Course, the implementation skills and programming understanding (HTML, CSS, JavaScript) will be assessed by an exercise in form of a practical exam (3 h). This is an open-book and open-internet exam. Students will bring their own computers and create a small programming project (e.g. a weather application) while present in a lecture hall. This will be graded according to specific requirements (e.g., “The Submit button is all caps via CSS”).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Beneficial is a basic knowledge in the area of software development, programming (Java, C, ...) or web page design.
All necessary techniques (JavaScript, HTML, CSS) are taught during the "Interaction Programming Block Course". Visiting the programming course is recomended for the practical course . Lack of experience has to be supplemented by (time-consuming & independent) self studies.

Content:
In order to be accepted, software products have to fulfill the needs of the user, while ensuring ease of use at the same time. Increasingly new prototyping technologies are used for the interaction and interface design. Therefore, within the course, students are expected to develop user interfaces in different design phases like early paper prototypes and full-scale working interaction prototypes iteratively. The students will independently (in teams of three to four persons) create interaction prototypes for product-specific tasks that will be evaluated in a usability context.

Intended Learning Outcomes:
After participating in the Interaction Prototyping Practical Course, students are able to
- understand and apply the user centred design software development process
- design and create their own interaction prototypes with necessary programming techniques such as HTML5/CSS3/JavaScript
- evaluate the created interaction concepts utilizing suitable techniques
- demonstrate own project results in front of a critical expert audience
- work in an interdisciplinary team

Teaching and Learning Methods:
The user centred design software development process is presented by a lecturer. Theoretical basics are taught and visualized via slides and prototyping (videos). The design and the assessment of interaction prototypes is reached by biweekly practical assignments and their fulfilment in groups of three to four persons. The practical assignments will be assisted by tutors in appointments of one weekly contact hour per group. Thus, complex issues can be clarified in direct discussion with the tutors that help the students to strengthen their understanding in interaction prototyping and programming.
The results of the biweekly practical assignments have to be presented in front of the course in four milestone presentations. Every team will be provided with a smartphone during the semester for development and testing purposes. Students will use their own laptops and preferred IDE for the development.

Media:
Slides
Socrative self tests during class
Videos
Web References
Exercises

Reading List:
Cooper, A., Reimann, R., & Cronin, D. (2007). About face 3: The essentials of interaction design. Indianapolis, IN: Wiley Pub.

Hogan, B. P. (2011). HTML5 and CSS3: Develop with Tomorrow's Standards Today. Full text available online: http://proquest.tech.safaribooksonline.de/9780980846904

W3Schools (2014). The world's largest web development site: educate yourself! Available online: http://www.w3schools.com/

Responsible for Module:
Bengler, Klaus; Prof. Dr. phil.

Courses (Type of course, Weekly hours per semester), Instructor:
Interaction Prototyping Practical Course (Praktikum, 3 SWS)

Bender J [L], Bengler K, Graefe J
For further information in this module, please click campus.tum.de or here.

Module Description

POL61501: A Primer on Political Decision-making for Engineers | A Primer on Political Decision-making for Engineers

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 module grade consist of a written term paper (50%) and an oral presentation during the seminar (50%). For this, students will pick a specific policy problem of their own choice and apply the theories covered in class to this case. Through the written paper (13-15 pages, excluding title page, references and appendices), students will document to which extent they have gained a foundational understanding of democratic policy making and whether they are able to apply theories and analyse specific policy problems. The accompanying presentation tests their communicative abilities to present a scientific topic to an audience.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
This course does not require any prior knowledge, but an interest in politics will be helpful.

Content:
This course will give engineering students a speed course in political decision-making processes, so they will be able to participate more effectively in this process. Politicians frequently have to make decisions on highly technical matters with wide implications for society. In this view, it is important that professionals with expert insight on technology are able to inform the decision making process, but this requires that engineers and natural scientists with this insight also have a basic understanding of the political system they are to inform.
Traditionally, engineering and natural sciences are often regarded as non-political endeavours that ought to act politically neutral and not be interfered with by politicians. However, with increasingly complex technologies, implemented in increasingly interconnected societies, it is impossible to make informed political decisions without some level of technical expertise and likewise it is impossible to simply consider technical decisions “politically neutral” solutions.

That is why this course is relevant for engineering students and students within the natural sciences, who are interested in working with or for politically governed organisations such as public institutions, international institutions, or third sector organisations, and want to understand how such organisations operate. Any engineering student who wants to understand the regulation that their engineering has to comply with will also benefit from this course.
Almost any type of engineering is subject to some level of political regulation. The course will introduce students to general theories of policy making, and demonstrate how these theories can be used to understand why and how different aspects of engineering are regulated the way they are.

Intended Learning Outcomes:
Upon successful completion of this module, students will have acquired a fundamental understanding of basic political processes, as well as a selection of theoretical frameworks to analyse these processes.
They will be able to apply different theoretical frameworks to explain why and how their own field of engineering is regulated the way it is, and analyse which political priorities and potential trade-off's need to be taken into account when regulating such fields.
Students will also have gained experience communicating basic analyses of political regulation both orally and in the form of a written report.

Teaching and Learning Methods:
The module consists of three parts. First, 4 weeks of 2 hour classes will introduce students to the theoretical foundations of the module. These lessons will mainly consist of direct instructions from the teacher, but will also allow a minimal level of student engagement. Secondly, students will be allowed around 4 weeks of self-guided study without classes where they should prepare their own case studies based on the theories introduced in the first part. Finally, the third part of the module consists of 4 weeks of 4 hour seminars where students present their case studies to each other and we discuss the implications of their analyses.

Media:
Scientific literature, slides, whiteboard.

Reading List:
Hall, P. A., & Taylor, R. C. (1996). Political science and the three new institutionalisms. Political Studies, 44(5), 936–957.

Responsible for Module:
Gad, Nikolai; MRes

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

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

Module Description

POL70045: Master Seminar Business Ethics | Masterseminar Wirtschaftsethik

Version of module description: Gültig ab summerterm 2015

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

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

Description of Examination Method:
Die Prüfungsleistung wird in Form einer 45-minütigen Präsentation während des Seminars erbracht, die außerdem zu verschriftlichen ist. Durch die Präsentation wird überprüft, ob die Studierenden in der Lage sind die erarbeiteten Inhalte innerhalb kurzer Zeit ihren Zuhörern überzeugend zu vermitteln. Durch im Anschluss stattfindendende Diskussion wird außerdem die Kritik- und Reflexionsfähigkeit der Teilnehmer geschult. Die Verschriftlichung dient der Einübung stringenten schriftlichen Argumentierens sowie des Umgangs mit wissenschaftlichen Quellen. Präsentation und Verschriftlichung werden jeweils einzeln benotet und fließen mit 75 % (Präsentation) und 25 % (Verschriftlichung) in die Bewertung ein.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Vorlesung "Einführung in die Wirtschaftsethik" (BSc)

Content:
1. Vorstellung aktueller Probleme der Wirtschaftsethik; 2. Diskussion methodischer Innovationen auf dem Gebiet der Wirtschaftsethik; 3. Kritische Auseinandersetzung mit verbreiteten Vorurteilen über die Marktwirtschaft; 4. Einübung konsistenter ethischer Argumentation im Rahmen von Rollenspielen; 5. Sensibilisierung für den naturalistischen Fehlschluss; 6. Erläuterung der Bedeutung empirischer Ergebnisse für die Wirtschaftsethik; 7. Schulung der Diskurskompetenz; 8. Entwicklung der Sozialkompetenz; 9. Entwicklung der Kritikfähigkeit; 10. Erwerb von Präsentationstechniken.

Intended Learning Outcomes:
Nach erfolgreichem Abschluss dieses Kurses sind die Studierenden in der Lage aktuelle Probleme der Wirtschaftsethik in einen theoretischen Rahmen einzuordnen und innerhalb dieses Rahmens konsistent zu argumentieren. Im Einzelnen können die Studierenden (1) konkrete Fallstudien in einen abstrakten wirtschaftsethischen Rahmen einordnen, (2) im Bereich der Wirtschaftsethik grundlegende Probleme reflektieren, die sich insbesondere auch durch das kritische Hinterfragen der eigenen Position auszeichnet, (3) eigene theoriebasierte wirtschaftsethische Überlegungen systematisieren und verschriftlichen.

Teaching and Learning Methods:
Das Masterseminar ermöglicht eine kritische Auseinandersetzung mit aktuellen wirtschaftsethischen Themen in Kleingruppen. Dabei wird insbesondere die Diskussionskompetenz der Teilnehmer geschult und deren Präsentationstechniken verbessert. Durch die Anfertigung einer Präsenation und die Zusammenfassung von deren Kernaussagen wird die stringente Verschriftlichung des eigenen Gedankengangs und dessen Einbindung in die existierende wissenschaftliche Literatur eingeübt. Mit der Hilfe von Liveexperimenten und Gedankenexperimenten erfahren die Studierenden ethische Dilemmata persönlich. Dies dient unmittelbar der Vorbereitung auf die Anfertigung der Masterarbeit.

Media:
Präsentationen, Handzettel, Gruppenarbeiten, Gedankenexperimente, Liveexperimente

Reading List:
Homann, Karl; Lütge, Christoph: Einführung in die Wirtschaftsethik, LIT Verlag, 3. Auflage

Responsible for Module:
Lütge, Christoph; Prof. Dr. phil.

Courses (Type of course, Weekly hours per semester), Instructor:
(POL7004501) Masterseminar Wirtschaftsethik (Interacting with Bots and Robots: Opportunities and Ethical Challenges) (Seminar, 2 SWS)
Boch A, Lütge C

(POL7004501) Masterseminar Wirtschaftsethik (Interacting with Bots and Robots: Opportunities and Ethical Challenges) (Seminar, 2 SWS)
Boch A, Lütge C

(POL7004501) Masterseminar Wirtschaftsethik (Interacting with Bots and Robots: Opportunities and Ethical Challenges) (Seminar, 2 SWS)
Boch A, Lütge C

(POL7004501) Masterseminar Wirtschaftsethik (Interacting with Bots and Robots: Opportunities and Ethical Challenges) (Seminar, 2 SWS)
Boch A, Lütge C

(POL7004501) Masterseminar Wirtschaftsethik (Interacting with Bots and Robots: Opportunities and Ethical Challenges) (Seminar, 2 SWS)
Boch A, Lütge C

(POL7004501) Masterseminar Wirtschaftsethik (Interacting with Bots and Robots: Opportunities and Ethical Challenges) (Seminar, 2 SWS)
Boch A, Lütge C

(POL700458) Masterseminar Wirtschaftsethik: (Ethics of Artificial Intelligence) (Seminar, 2 SWS)
Boch A, Lütge C, Pires Bernardo Ramos Fontes A, Poszler F

(POL7004511) Masterseminar Wirtschaftsethik (AI Ethics in Practice) (Seminar, 2 SWS)
Lütge C, Poszler F

(POL700456) Masterseminar Wirtschaftsethik (Corporate Social Responsibility) (Seminar, 2 SWS)
Thejls Ziegler M (Max R)
For further information in this module, please click campus.tum.de or here.

Module Description

SOT53200: Responsibility in the Engineering Profession | Verantwortung im Ingenieurberuf

Applied Ethics for Engineers

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
The examination consists of of a presentation (15 - 20 minutes) and an essay (1000 - 1200 words) in which the students demonstrate their analytical-argumentative abilities:
- to identify different conflicting goals of their profession, which are elaborated in the course, with regard to functional, social-normative and ethical implications and classify them critically argumentatively;
- to classify and apply different models of responsibility ethics taught in the seminar with regard to divers applications (case studies);
- to present an analysis and application of different models of responsibility ethics taught in the course by means of examples from the field of activity;
- to present and discuss their results in a concise analytical-argumentative form.

The work must be accompanied by a graded presentation (15 - 20 minutes). The weighting of the marks is 70% for the essay and 30% for the presentation.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
No knowledge.

Content:
The module introduces students to the following topics:
General issues of normative and applied ethics;
Responsibility in the professional field of civil and environmental engineering;
Recognising, classifying and evaluating professional, social-normative and ethical conflicts of objectives;

models and methods of responsible problem-solving competence;
Implementation of technical solutions (models): stakeholders, social acceptance, sustainability goals (in terms of normative guard rails, responsible communication and implementation).

Intended Learning Outcomes:
On successful completion of this module students will be:
- familiar with basic social normative and ethical challenges in the field of engineers' activities;
- understand the most important topics and issues in the field of ethics of responsibility;
- are able to analyse, classify and assess activity-related conflicts of objectives;
- are able to analyse und to discuss critically models of responsible problem-solving competence with regard to the implementation of technical solution strategies.

Teaching and Learning Methods:
The module introduces students to the following topics:
General issues of normative and applied ethics;
Responsibility in the professional field of civil and environmental engineering;
Recognising, classifying and evaluating professional, social-normative and ethical conflicts of objectives;
models and methods of responsible problem-solving competence;
Implementation of technical solutions (models): stakeholders, social acceptance, sustainability goals (in terms of normative guard rails, responsible communication and implementation).

Media:
Literature, reader, presentation and discussion

Reading List:

Responsible for Module:
Jörg Wernecke

Courses (Type of course, Weekly hours per semester), Instructor:
Verantwortung im Ingenieurberuf. Angewandte Ethik für Ingenieurinnen und Ingenieure (Seminar, 2 SWS)
Wernecke J
For further information in this module, please click campus.tum.de or here.

Module Description

SOT86750: sustAInability | sustAInability

Version of module description: Gültig ab summerterm 2024

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 module examination is a project work with a final presentation. The project work is composed of the submission of an essay on the analysis of a case study, a project report and a final presentation. The essay (1000 words) counts for 40% of the module grade, the project report (6-8 pages) and the final presentation (15 min) together for 60%. In the first phase of the project work, students research a use case in the field of Digital Technology and Sustainability, which they then analyze and discuss. The result of this analysis is submitted in the form of an essay (1000 words). With the essay, students prove that they are able to independently work on a complex topic, to take over different perspectives and to write scientifically. Furthermore, students will team up in interdisciplinary groups and sign up for the nationwide competition “Digital Future Challenge”. They will get to choose real world challenges in the field of technology and sustainability and will work on a pitch deck and a pitch presentation over the rest of the semester. The final results of their technical and non-technical solutions will be presented at a public pitch night. With the development and the presentation of a solution, students prove that they are able to collaboratively work together in interdisciplinary teams, that they are able to understand and analyze complex problems and to develop feasible technical and non-technical solutions at the intersection of technology and sustainability. After successfully completing their project work, they are also able to pitch and present their ideas to a public conference as well as to narrate their project process in a comprehensible report.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
This module is aimed at all students enrolled in a Master or third year of Bachelor program at the TUM or the Hochschule München University of Applied Sciences (HM); it is thus designed as an interdisciplinary venue which brings together a range of scientific perspectives. Its project-

based character requires high levels of intrinsic motivation and the willingness to actively participate in a project. Students with a technological background are as welcome as students from social sciences, economics, design or humanities. Since we will participate in the nationwide university competition "Digital Future Challenge" in this seminar, at least basic German skills are recommended.

Content:
Sustainability as a central, political and societal goal, can instead serve as an orientation framework for the responsible development of technologies as well as a compass for their use. For this to succeed, both sociological and technical perspectives are necessary. For universities - but also for other institutions in politics, society and business - this means that disciplinary boundaries must increasingly be broken down and interdisciplinary teaching and learning formats should be created. One such format is "sustAInability" during which students approach digital technologies, such as AI from various sustainability perspectives in a self-study phase and seminar units, and then develop application-oriented technical and non-technical solutions in the context of the Digital Future Challenge.

During the self study phase and the seminar sessions, students will read relevant literature, watch videos and complete assignments, prepare short presentations, attend lectures and subsequently discuss the gained insights.
All students are expected to sign up to the university competition “Digital Future Challenge”.
In teams they work on a selected use case and submit a pitch deck. The development of the technical and non-technical solutions will be accompanied by online workshops by the organizers of the challenge (Initiative D21 and Deloitte Foundation) as well as regular on-site seminar sessions. Based on the quality of the pitch decks a jury will invite some teams to pitch at the nationwide semi-finals and the final in Berlin. More information on the competition can be found here: https://www.digital-future-challenge.de/digital-future-challenge/

Intended Learning Outcomes:
After successful participation in this module, students are able:
- to independently acquire knowledge and to put their knowledge, particularly in the context of artificial intelligence and sustainability, into practice e.g. in the form of written essays or presentations in class
- to systematically plan, design, and implement solutions with respect to sustainability and digital technologies in a team project to apply their knowledge
- to work together in an interdisciplinary team and to present their project results in a public pitch.

Teaching and Learning Methods:
The module contains self-study phases as well as weekly seminar sessions and a total of four half-day workshops. Following the idea of flipped-classroom, students are expected to acquire knowledge during the self-study phase to be able to participate in profound discussions during the

seminar sessions and to participate in the Digital Future Challenge Competition by actively tackling a current challenge in the field of digital technologies and sustainability.
The module draws on the ideas of service-learning and project-based learning. A range of teaching & learning techniques will be applied:
Self-Learning: Students will be provided with a reading list, news articles, podcasts, and videos on an online platform. These materials allow students to individually gain first insights on the topic. The accompanying written assignments as well as the short presentation on a specific topic will help them to structure the newly acquired knowledge.
Group work: Students will learn to apply agile methods and work on their projects in groups. Progress will be assessed through project presentations by the end of the seminar as well as continuous feedback from the instructors, from external experts, and as peer-to-peer feedback.
Presentational skills: Will be further facilitated through the requirement to present ongoing and final results within the seminar, at the public events of the Digital Future Challenge and at a final presentation in Munich.

Media:
Computer, presentations, documents, videos, podcasts

Reading List:
• OECD (2022), Blogpost: Measuring the environmental impacts of artificial intelligence compute and applications: The AI footprint"
• Rolnick, D. et al. (2022). Tackling Climate Change with Machine Learning
• Van Wynsberghe, A. (2021). Sustainable AI: AI for sustainability and the sustainability of AI
• Vinuesa R. et al. (2020). The role of artificial intelligence in achieving the Sustainable Development Goals

Responsible for Module:
von Schwichow, Helene; M.A.

Courses (Type of course, Weekly hours per semester), Instructor:
(SOT86750) sustAInability (Seminar, 4 SWS)
von Schwichow H, Wurster S (Schmid H)
For further information in this module, please click campus.tum.de or here.

Module Description

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

How to make game-changing decisions

Version of module description: Gültig ab winterterm 2017/18

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

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

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

Repeat Examination:
End of Semester

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

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

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

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

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

Media:
presentations
founders in class
video

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

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

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

Module Description

AR17041: Climate responsive Building II | Klimagerechtes Bauen II

Version of module description: Gültig ab winterterm 2018/19

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:
Duration time 60 minutes. Written exam. (electronic lecture hall exam)

At the end of the module the proof of performance will be a written examination. In the exam the students proof that they are able to evaluate the complex correlation of climate responsive and energy optimized building. On the basis of practical examples it is examined that the students are able to create appropriate measures and concepts. Content is over the whole semester. Answers can be given in own words or given single-choice-questions. Furthermore basic calculations should be solved.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
- Olfactory, visual and acoustic comfort
- Climate responsive building: architecture strategies (passive) to optimize the building climate and energetic supply of buildings through an integrated planning approach
- Integration of building's envelope and building technology (adjusting screw of the facade and adjustment of facade and room conditioning)
- Room conditioning: ventilation, lightning
- Technical building installation
- Daylight usage and sun protection, energy-efficient artificial lighting systems
- Simulation tools
- Legal and energy economical framework

Intended Learning Outcomes:
At the end of the module students are able to:
- name the correlations between the building's envelope and the required comfort demands and apply the resulting knowledge
- design holistic, climate responsive and energy optimized building concepts
- create sustainable concepts of room conditioning
- evaluate passive (architectural) measures for minimizing the energy demand of buildings while optimizing the comfort
- adapt individual technical systems of room conditioning to the building concept or coordinate the individual systems among themselves
- analyse practical examples with regard to climate responsive and energy optimized buildings
- understand the current political and scientific state of debate regarding to buildings and urban structures in the context of the energy revolution
- on this state of knowledge suitable systems and technologies can be choosen and founded

Teaching and Learning Methods:
The practical relevance is established by current projects and students' discussion. In the weekly lectures the content of the module is mediated in form of lecture and presentation and tested in a written exam.

Media:
PowerPoint presentation, script, blackboard

Reading List:
ClimaDesign Gebäude die mit weniger Technik mehr können
Hausladen,Saldanha,Liedl,Sager Callwey Verlag

ClimaSkin Hausladen,Saldanha,Liedl Callwey Verlag

Ausbauatlas Hausladen,Tichelmann Edition Detail, 2009

Responsible for Module:
Vohlidka, Philipp; Dipl.-Ing. (Univ.)

Courses (Type of course, Weekly hours per semester), Instructor:
Klimagerechtes Bauen II (Vorlesung, 2 SWS)
Auer T, Schmid T
For further information in this module, please click campus.tum.de or here.

Module Description

BGU900015: Partner University - Elective Module | Partneruniversität - Wahlmodul

Version of module description: Gültig ab summerterm 2015

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

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

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

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

Module Description

BGU900013: Partner University - Elective Module | Partneruniversität - Wahlmodul

Version of module description: Gültig ab winterterm 2013/14

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

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

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

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

Module Description

BGU900014: Partner University - Elective Module | Partneruniversität - Wahlmodul

Version of module description: Gültig ab summerterm 2015

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

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

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

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

Module Description

AR30226: Advanced Topics Computational Design II | Spezialthemen Computational Design II

Version of module description: Gültig ab summerterm 2018

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

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

Description of Examination Method:
Die Modulprüfung wird in Form einer Projektarbeit erbracht. Das zu behandelnde Thema variiert semesterweise und behandelt aktuelle Entwicklungen im Bereich der Informationstechnologie im Bereich der Architektur.
Im Rahmen der Projektarbeit werden während des Semesters verschiedene Meilensteine der Arbeit präsentiert. Am Semesterende wird eine Dokumentation der Ergebnisse (Broschüre, 20-30 Seiten) in analoger und digitaler Form eingereicht und präsentiert. Je nach Aufgabenstellung können ergänzenden Medien wie Renderings, Modellen oder Videos/Animationen als Abgabeleistung hinzukommen.
Anhand der Konzeption, Umsetzung und Dokumentation der Arbeiten wird überprüft, inwiefern die Studierenden in der Lage sind, Methoden des Computational Design in einem interdisziplinären Kontext auf architektonische und städtebauliche Themen und Fragestellungen anzuwenden. Dies betrifft die Einordung, wie auch die Erarbeitung selbstständiger computergestützter Methoden, sowie deren Strukturierung, Interpretation und Repräsentation.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Voraussetzung für alle Kursteilnehmer ist Offenheit und Interesse an Zusammenarbeit in einem interdisziplinären Kontext. Dazu müssen die Studierenden fundierte Kenntnisse im Entwurf und dem Umgang mit etablierten Entwurfs- und Darstellungsmethoden besitzen, um computergestützte Werkzeuge aus architektonischer Sicht bewerten und in den Arbeitsprozess einordnen zu können. Grundkenntnisse im Umgang mit Rechnern sind erforderlich.

Content:
Im Zentrum des Moduls steht die praktische Auseinandersetzung mit interdisziplinärem Denken und der Erschließung neuer Arbeitsfelder an der Schnittstelle zu verschiedenen Disziplinen wie beispielsweise Informationstechnologie, Medieninformatik oder Betriebswirtschaft. In seminaristischer Form werden architektonische oder architekturbezogene Problemstellungen identifiziert und Themen erarbeitet um in einer kreativen Auseinandersetzung neue Lösungsansätze zu erarbeiten. Fachlich stehen mit Konzepten und Methoden des parametrischen und algorithmischen Entwerfens, Simulationsmethoden, grafisch visuellen Entwurfsumgebungen, digitalen Darstellungsmethoden und der Mensch-Maschine-Kommunikation, Themen des Computational Design sowie Ansätze des Managements, der Soziologie und des Designs im Fokus.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage,
- komplexe Anforderungen und Konzepte im Entwurfs- und Planungsprozess zu erkennen, zu strukturieren, zu analysieren und zu präsentieren
- selbstständig Problemstellungen zu analysieren und Strategien im Umfeld des Computational Designs abzuleiten,
- computergestützte Entwurfsmethoden zu konzipieren,
- Mock-Ups und Prototypen zu entwickeln und zu implementieren,
- künftige IT- Methoden für die Entwurfsunterstützung kritisch einzuordnen

Teaching and Learning Methods:
Im Modul werden in Vorträgen die theoretische Inhalte Dozent/inn/en vermittelt und durch Expertinnen und Experten aus der Praxis angereichert. Die Einführung in Programmsysteme erfolgt in seminaristischer Form durch Dozent/inn/en. Die Studierenden werden zum Studium der Literatur und der inhaltlichen Auseinandersetzung mit den Themen angeregt. Durch Referate werden die theoretischen Grundlagen vertieft und anhand einer architektonischen Aufgabenstellung praktisch angewandt, welche am Ende des Semesters in digitaler und analoger Form einzureichen sind.

Media:
Im Vorlesungsteil werden die Inhalte mit Projektionen vermittelt. Die Einführung in Programmsysteme erfolgt in seminaristischer Form am PC. Die Folien der Vorträge, grundlegende Literaturquellen und weitere Vorlagematerialien werden auf der Lernplattform der TUM zur Verfügung gestellt.

Reading List:
Lehrmaterial wird semesterweise im Internet ergänzend neben Grundlagenwerken zur Verfügung gestellt
- Buxton, W. (2007): Sketching User Experiences, Morgan Kaufmann 2007.
- Gharajedaghi, J. (2011): Systems Thinking: Managing Chaos and Complexity. Morgan Kaufmann.
- Sawyer, K. (2008): Group Genius. New York: Basic Books

Responsible for Module:
Petzold, Frank; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Spezialthemen Computational Design II (Seminar, 4 SWS)
Petzold F, Förster N
For further information in this module, please click campus.tum.de or here.

Module Description

AR30294: Climate Responsive Building I | Klimagerechtes Bauen I

Version of module description: Gültig ab winterterm 2022/23

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:
Duration time 60 minutes. electronic lecture hall exam

In the exam the students proof that they are able to evaluate the complex correlation of climate responsive and energy optimized building. On the basis of practical examples it is examined that the students are able to create appropriate measures and concepts. Content is over the whole semester. Answers can be given in own words or given single-choice-questions. Furthermore basic calculations should be solved.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse der Gebäudetechnik, Kenntnisse über die Bilanzierung von Gebäuden in energetischer und
ökologischer Hinsicht.

Content:
- Climate and climatic parameters
- Fundamentals of energy and renewable energy
- Thermal comfort
- Climate responsive building: architecture strategies (passive) to optimize the building climate and energetic supply of buildings through an integrated planning approach
- Integration of building's envelope and building technology (adjusting screw of the facade and adjustment of facade and room conditioning)
- Winter and summer insulation
- Energy balance of the building in heating and cooling mode
- Room conditioning: heating, cooling

- Technical building installation
- Energy conversion and energy supply, central and decentralised energy supply concept, energy storage
- Simulation tools
- Legal and energy economical framework

Intended Learning Outcomes:
At the end of the module climate responsive building students are able to
- design holistic, climate responsive and energy optimized building concepts
- create sustainable concepts of room conditioning and energy supply for buildings and quarters
- evaluate passive (architectural) measures for minimizing the energy demand of buildings while optimizing the comfort
- adapt individual technical systems of room conditioning to the building concept or coordinate the individual systems among themselves
- analyse practical examples with regard to climate responsive and energy optimized buildings
- understand the current political and scientific state of debate regarding to buildings and urban structures in the context of the energy revolution

Teaching and Learning Methods:
The practical relevance is established by current projects and students' discussion. In the weekly lectures the content of the module is mediated in form of lecture and presentation and tested in a written exam.

Media:
PowerPoint presentation, script, blackboard

Reading List:

Responsible for Module:
Vohlidka, Philipp; Dipl.-Ing. (Univ.)

Courses (Type of course, Weekly hours per semester), Instructor:
Klimagerechtes Bauen I (Vorlesung, 2 SWS)
Auer T, Koth S, Schmid T, Zettelmeier C
For further information in this module, please click campus.tum.de or here.

Module Description

AR30362: Rendertube | Rendertube

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**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:
Die Modulprüfung wird in Form einer Projektarbeit erbracht. Im Rahmen der Projektarbeit werden während des Semesters verschiedene Darstellungen anhand der behandelten Visualisierungsmethoden erstellt und präsentiert. Am Semesterende muss eine dokumentierte Mappe mit den erarbeiteten computergestützten Darstellung in analoger und digitaler Form eingereicht und präsentiert werden. Anhand der Darstellungen wird überprüft, inwiefern die Studierenden in der Lage sind, digitale Werkzeuge zur adäquaten Darstellung und Präsentation von Architektur anzuwenden. Dies betrifft die Einordung, wie auch die Erstellung selbstständiger Strategien zur Modelldatenerstellung, Strukturierung, Überführung sowie computergestützten Darstellung.

Repeat Examination:

(Recommended) Prerequisites:
Die Studierenden sollten grundlegende Kenntnisse im Entwurf und dem Umgang mit etablierten Darstellungsmethoden besitzen. Aufbauend darauf können computergestützte Werkzeuge aus architektonischer Sicht bewertet und in den Arbeitsprozess einordnet werden. Grundkenntnisse im Umgang mit Rechnern sind dringend erforderlich.

Content:
Eine gute Entwurfsidee ist nur der erste Schritt zum Erfolg! Der Entwurfsgedanke muss adäquat kommuniziert werden. Neben den etablierten Medien, wie Skizze, Werkplan und physisches Modell, werden heute verstärkt digital erzeugte Medien, wie etwa Renderings oder 360 Panoramen eingesetzt. Der Schwerpunkt des Kurses liegt in der Erzeugung authentischer und überzeugender Visualisierungen mit Cinema 4D. Im Seminar wird neben einer Einführung in das Visualisierungsprogramm Cinema 4D gezeigt, wie aus dem 3D-Modell ein gutes Rendering

abgeleitet werden kann und wie dies in weiterführenden Schritten mit zum Beispiel Photoshop, weiter aufbereitet werden kann.

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage, digitale Werkzeuge für adäquate Darstellung / Präsentation einzuordnen und selbstständig Strategien zur Modelldatenerstellung, -strukturierung, -überführung und computergestützten Darstellung zu konzipieren:

... komplexe Softwaresysteme für Darstellung / Präsentation eigenständig zu erschließen
... Darstellungs- und Präsentationsmöglichkeiten effizient zu nutzen
... Qualitäten von Architektur anhand einer oder mehrere Darstellungsmethoden zu erfassen
... Darstellungsmittel gestalterisch, experimentell sowie konzeptionell so zu wählen, dass sie dem Betrachter einem intellektuellen, emotionalen und inhaltlichen Kontext des Entwurfs aufzeigen.

Teaching and Learning Methods:
Im Seminar werden in Vorträgen das nötige Wissen vermittelt und durch Expertinnen und Experten aus der Praxis angereichert. Die Studierenden werden zum Studium der Literatur und der inhaltlichen Auseinandersetzung mit den Themen angeregt. Durch Referate werden die theoretischen Grundlagen vertieft und an Hand einer architektonischen Aufgabenstellung praktisch angewandt, welche am Ende des Semesters in digitaler und analoger Form einzureichen sind.

Media:
In Vorträgen werden die Inhalte von Lehrstuhlmitarbeiterinnen und -mitarbeitern vermittelt sowie durch Expertinnen und Experten aus der Praxis angereichert.
Die Folien der Vorträge, grundlegende Literaturquellen und weitere Vorlagematerial werden auf der Lernplattform der TUM zur Verfügung gestellt.

Reading List:
Lehrmaterial zu den verwendeten Softwarelösungen und Grundlagenliteratur zu Methoden analoger / computergestützten Präsentation werden semesterweise im Internet zusammengestellt.

Responsible for Module:
Dr. Gerhard Schubert

Courses (Type of course, Weekly hours per semester), Instructor:
Rendertube (Seminar, 4 SWS)
Schubert G
For further information in this module, please click campus.tum.de or here.

Module Description

AR30363: Algorithmic Design | Algorithmic Design

Version of module description: Gültig ab summerterm 2018

Module Level: Master	**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:
Die Modulprüfung wird in Form einer Projektarbeit erbracht. Im Rahmen der Projektarbeit werden während des Semesters interaktive Software-Prototypen anhand der behandelten Methoden erstellt und Meilensteine der Arbeit präsentiert. Am Semesterende wird eine Dokumentation der Ergebnisse (Broschüre, 20-30 Seiten) in analoger und digitaler Form eingereicht und präsentiert. Anhand von Konzeption, Umsetzung und Dokumentation der in der Projektarbeit entstandenen Prototypen wird überprüft, inwiefern die Studierenden in der Lage sind, Methoden der Informationstechnologie auf architektonische und städtebauliche Themen und Fragestellungen anzuwenden. Dies betrifft die Einordnung, wie auch die Erstellung selbstständiger Strategien zur Datenerschließung, Strukturierung, Überführung sowie deren computergestützten Interpretation und Darstellung.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Die Studierenden müssen fundierte Kenntnisse im Entwurf und dem Umgang mit etablierten Entwurfs- und Darstellungsmethoden besitzen, um computergestützte Werkzeuge aus architektonischer Sicht bewerten und in den Arbeitsprozess einordnen zu können. Grundkenntnisse im Umgang mit Rechnern sind dringend erforderlich.

Content:
Für Architekten und Stadtplaner sind Rechner heutzutage selbstverständliche Arbeitsmittel. Die Vernetzung und die damit verbundene Möglichkeit, Daten weltweit unmittelbar und verlustfrei zu kommunizieren beeinflusst Planungs- und Entwurfsprozesse in immer stärkerem Maße.
Im Arbeitsalltag von Architekten und Stadtplanern hängt die Fähigkeit zur Bewältigung und Kommunikation architektonischer Fragestellungen zunehmend davon ab, wie sie die Potentiale der Informationstechnologie in ihrer Arbeit umzusetzen vermögen. Diese Potentiale gehen dabei

über die heutzutage schon mit großer Selbstverständlichkeit genutzten High-End-Renderings und parametrischen Modellierwerkzeuge hinaus, die mittlerweile zum Mainstream gehören und erfolgreich Einzug in die Architekturbüros erhalten haben.
Im Modul werden Kenntnisse und Fähigkeiten vermittelt, um Unterstützungen im Kontext von Architektur und Städtebau durch Methoden der Informationstechnologie zu identifizieren, zu entwickeln und zu formulieren. Die Teilnehmer werden in die Lage versetzt, Architektur mittels Algorithmen zu beschreiben, zu generieren, zu bewerten, darzustellen und zu kommunizieren. Neben den theoretischen Grundlagen werden Programierwerkzeuge wie Processing vermittelt, um dieses Feld zu erkunden.

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage
- erweiterte Methoden zur Informations- und Datenmodellierung für eine adäquate Darstellung einzuordnen,

- Methoden der Informations- und Datenvisualisierung effizient zu nutzen,
- Algorithmen und Datenstrukturen auf architektonische und städtebauliche Themen und Fragestellungen anzuwenden,
- Potentiale von Informationstechnologie zur Unterstützungen im Kontext von Architektur und Städtebau zu identifizieren, zu entwickeln und zu formulieren.
- Architektur bzw. architektonische Problemstellungen mittels Algorithmen zu beschreiben, zu generieren, zu bewerten, darzustellen und zu kommunizieren.

Teaching and Learning Methods:
Im Modul wird in Vorträgen das nötige Wissen von Dozent/inn/en vermittelt und durch Expertinnen und Experten aus der Praxis angereichert. Die Studierenden werden zum Studium der Literatur und der inhaltlichen Auseinandersetzung mit den Themen angeregt. Durch Referate werden die theoretischen Grundlagen vertieft und an Hand einer architektonischen Aufgabenstellung praktisch angewandt, welche am Ende des Semesters in digitaler und analoger Form einzureichen sind.

Media:
In dem Modul werden theoretische Inhalte in Form von Vorträgen mit Projektionen gehalten. In seminaristischer Form werden die Softwarewerkzeuge am PC eingeführt. Die Folien der Vorträge, grundlegende Literaturquellen und Vorlagematerialien werden auf der Lernplattform der TUM zur Verfügung gestellt.

Reading List:
Lehrmaterial wird semesterweise im Internet zur Verfügung gestellt.

Responsible for Module:
Frank Petzold (info@ai.ar.tum.de)

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

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

Module Description

AR30364: Parametric Design | Parametric Design

Version of module description: Gültig ab summerterm 2018

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

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

Description of Examination Method:
Die Modulpru#fung wird in Form einer Projektarbeit erbracht. Am Semesterende müssen eine Dokumentation der Ergebnisse (Broschüre, 20-30 Seiten), das parametrische Modell und die Präsentation in digitaler Form eingereicht und präsentiert werden. Anhand der Abgabe wird überprüft, inwiefern die Studierenden in der Lage sind, digitale Werkzeuge zur Modellierung geometrisch-parametrischer Abhängigkeiten von Architektur anzuwenden. Dies betrifft die Einordnung, wie auch die Erstellung selbstständiger Strategien zur Modelldatenerstellung, --strukturierung, --überführung sowie Beschreibung des parametrischer Ansatzes.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Die Studierenden müssen fundierte Kenntnisse im Entwurf und dem Umgang mit etablierten Entwurfsmethoden besitzen, um computergestützte Werkzeuge aus architektonischer Sicht bewerten und in den Arbeitsprozess einordnen zu können.
Grundkenntnisse im Umgang mit Rechnern sind dringend erforderlich.

Content:
Kenntnisse und Fähigkeiten im Umfeld digitaler parametrischer Werkzeuge im Entwurfsprozess sind essential, um das Potential des Digitalen für die Unterstützung im Entwurfsprozess zu erschließen. Im Zentrum des Moduls steht die praktische Auseinandersetzung mit der Methodik der parametrischen Modellierung im Entwurfs- und Planungsprozess. Dies umfasst die Strukturierung von Problemstellungen, deren algorithmische Beschreibung und Abbildung in parametrischen Systemen. Anhand von verfügbaren parametrischen Softwareumgebungen, wie das 3D-Modellierungsprogramm Rhinoceros und das parametrische Plugin Grasshopper oder Autodesk Revit und Dynamo, werden die notwendigen Schritte im parametrischen

Entwurfsprozess - Strukturierung, Modellbildung und algorithmische Beschreibung - aufgezeigt und das dafür notwendige theoretische Wissen vermittelt.

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage:
- parametrische Werkzeuge und Methoden für den Einsatz im Entwurfskontext einzuordnen und zu analysieren,
- architektonische und städtebauliche Fragestellungen zu strukturieren, algorithmisch zu beschreiben und parametrische Modell abzuleiten,
- selbstständig Strategien zur Modelldatenerstellung, -strukturierung, -überführung und computergestützten Abbildung sowie Modellierung geometrischer Zusammenhänge zu erarbeiten,
- tendenzielle parametrische Softwaresysteme inkl. Algorithmen und Datenstrukturen für Entwurfsaufgaben eigenständig zu erschließen.

Teaching and Learning Methods:
Das Modul besteht aus der Vermittlung theoretischer sowie praktischer Aspekte. In Form von Vorträgen wird das notwendige theoretische Wissen von Dozent/inn/en vermittelt und durch Expertinnen und Experten aus der Praxis angereichert. Die praktischen Fähigkeiten werden anhand verfügbarer Softwareumgebungen in Form von Übungen durchgeführt. Die Studierenden werden zum Studium der Literatur und der inhaltlichen Auseinandersetzung mit den Themen angeregt.

Media:
In dem Modul werden Inhalte in Form von Vorträgen mit Projektionen gehalten. Die Einführung in Programmsysteme erfolgt in seminaristischer Form am PC. Die Folien der Vorträge, grundlegende Literaturquellen und weitere Vorlagematerialien werden auf der Lernplattform der TUM zur Verfügung gestellt.

Reading List:
Lehrmaterial wird semesterweise im Internet zur Verfügung gestellt

Responsible for Module:

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

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

Module Description

AR30365: Interactive Visualization | Interaktive Visualisierung

Version of module description: Gültig ab summerterm 2018

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

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

Description of Examination Method:
Die Modulpru#fung wird in Form einer interdisziplinären Projektgruppenarbeit erbracht. Während des Semesters werden schrittweise die einzelnen Phasen in der Erarbeitung interaktiver Visualisierungen durchlaufen. Am Semesterende müssen eine Dokumentation der Ergebnisse (Broschüre, 20-30 Seiten), das interaktive Modell (Games-Engine Quelltext), die Präsentation und der Screencast in digitaler Form eingereicht und präsentiert werden. Anhand der Abgabe wird überprüft, inwiefern die Studierenden in der Lage sind, digitale Werkzeuge zur adäquaten interaktiven Darstellung und Präsentation von Architektur anzuwenden. Dies betrifft die Einordung interaktiver Visualisierungen in den Entwurfs- und Planungsprozess, sowie die selbstständige Erarbeitung von Strategien hinsichtlich Darstellungskontext, Darstellungsweise und Interaktionspotential.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Die Studierenden müssen fundierte Kenntnisse im Entwurf und dem Umgang mit etablierten Entwurfsmethoden besitzen, um computergestützte Werkzeuge aus architektonischer Sicht bewerten und in den Arbeitsprozess einordnen zu können. Grundkenntnisse im Umgang mit Rechnern sind dringend erforderlich.

Content:
Die Kommunikation von Entwürfen ist ein wesentliches Tätigkeitsspektrum im Berufsleben von Architekten. Neben etablierten Darstellungsmethoden werden verstärkt computergenerierte 2D- Darstellungen sowie digital gefertigte physische Modelle genutzt. Die Digitalisierung bietet jedoch Potentiale, die heute kaum erschlossen sind. Im Rahmen der Lehrveranstaltung werden Möglichkeiten der interaktiven 3D Architekturdarstellung behandelt, um Architektur virtuell dreidimensional erlebbar zu gestalten. Zudem können weitere Informationsebenen

hinzugeschalten werden, um Entwurfsintensionen besser zu kommunizieren. In der Veranstaltung werden die einzelnen Schritte in der Konzeption und Umsetzung interaktiver Visualisierung durchlaufen, vom Storyboard, der Auswahl geeigneter Interaktions- und Navigationsmechanismen, über die adäquaten Darstellungstiefe bis zur Umsetzung mittels einer Gameengine bspw. Unity 3D.

Intended Learning Outcomes:
Das Modul befähigt die Studierenden Potenziale und Grenzen interaktiver Visualisierungstechnologien im architektonischen Kontext zu analysieren sowie in kritischer Auseinandersetzung und Einordnung dieser Werkzeuge als neues Medium im Tätigkeitsspektrum der Architektur zu bewerten.
Nach der Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage:
- Methoden der interaktiven Visualisierung als Arbeits- und Präsentationswerkzeuge neben etablierten Mitteln der Architekturdarstellung kritisch einzuordnen,
-gestalterische, experimentelle sowie konzeptionelle digitale Werkzeuge zur Kommunikation und Darstellung architektonischer Fragestellungen einzusetzen,
- begründbare Lösungsansätze und Formulierungen von Konzepten unter den Aspekten der Informationsdarstellung und Interaktion in strukturierter Arbeitsweise zu entwicklen,
- aktuelle und tendenzielle Soft- und Hardwarelösungen einzuschätzen und zu erschließen,
- interdisziplinäre Schnittstellenkompetenzen zu entwickeln.

Teaching and Learning Methods:
Das Modul besteht aus einem theoretischen und praktischen Teil. In Form von Vorträgen werden Dozent/inn/en die notwendigen theoretische Grundlagen zur Gestaltung von Nutzerschnittstellen, zur Informations-/Architekturdarstellung und zu Interaktionsmechanismen behandelt sowie Kenntnisse zur Programmierung interaktiver Systeme behandelt und durch Expertinnen und Experten aus der Praxis angereichert.
Die praktischen Fähigkeiten werden anhand verfügbarer Softwareumgebungen in Form von Übungen durchgeführt. Die Studierenden werden zum Studium der Literatur und der inhaltlichen Auseinandersetzung mit den Themen angeregt. Durch die Kommunikation mit anderen Disziplinen werden interdisziplinäre Denkwesen trainiert.

Media:
Im Vorlesungsteil werden die Inhalte mit Projektionen vermittelt. Die Einführung in Programmsysteme erfolgt in seminaristischer Form am PC. Die Folien der Vorträge, grundlegende Literaturquellen und weitere Vorlagematerialien werden auf der Lernplattform der TUM zur Verfügung gestellt.

Reading List:
Lehrmaterial wird semesterweise im Internet zur Verfügung gestellt.

Responsible for Module:
Frank Petzold (info@ai.ar.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Interaktive Visualisierung (Seminar, 4 SWS)
Petzold F, Bratoev I, Schubert G
For further information in this module, please click campus.tum.de or here.

Module Description

AR30366: Performance Based Design | Performance Based Design

Version of module description: Gültig ab summerterm 2018

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

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

Description of Examination Method:
Die Modulprüfung wird in Form einer Projektarbeit erbracht, diese ist in Zwischenkritiken und einer Schlusskritik zu präsentieren. Am Semesterende müssen eine Dokumentation der Ergebnisse (Broschüre, 20-30 Seiten) eingereicht werden, die aus einer Dokumentation des Projektverlaufs, einer Darstellung der selbsterörterten Problemstellung, wie auch des Lösungsansatzes und Konzeptes, einer prototypischen Implementierung und der Schlusspräsentation besteht.
Anhand der Projektarbeit wir überprüft, in welcher Form der Einsatz digitaler Werkzeuge in architektonische Planungs- und Entwurfsphasen möglich und sinnvoll ist. Die Beurteilung erfolgt anhand eines Prototypen als proof of concept. In Zwischenkritiken und der ca. 10 minütigen Schlusspräsentation wird überprüft, inwiefern die eigene Arbeit im Diskurs auch gegen kritische Anmerkungen verteidigt werden kann.

Repeat Examination:

(Recommended) Prerequisites:
Die Studierenden müssen fundierte Kenntnisse im Entwurf und dem Umgang mit etablierten Entwurfsmethoden besitzen, um computergestützte Werkzeuge aus architektonischer Sicht bewerten und in den Arbeitsprozess einordnen zu können.
Grundkenntnisse im Umgang mit Rechnern sind dringend erforderlich.

Content:
Für Architekten und Stadtplaner sind Rechner heutzutage selbstverständliche Arbeitsmittel. Dank parametrischer Software lassen sich immer komplexere, gestalterisch neue Formen für den Architekturentwurf erzeugen. Neue Softwarelösungen wie etwa Grasshopper und Generative Components stehen den Architekten bei ihren Entwurfsfindungen zur Seite. Das Potential dieser Werkzeuge geht jedoch über formalistische Ansätze, d.h. der Erzeugung beliebiger Freiformen weit hinaus.

Ziel des Moduls ist es, das Potential parametrischer Entwurfssoftware bei Analyse und Modellierung einzelner Entwurfselemente auszunutzen. Es werden IT-Konzepte erarbeitet, um beispielsweise Fragen zur energetischen, räumlichen, statischen, finanziellen, baurechtlichen „Performance“ des Entworfenen zu untersuchen und zu bewerten.

Das Modul vermittelt Kenntnisse und Fähigkeiten zur Analyse der Planungs- und Entwurfsphasen, der eigenständigen Untersuchung relevanter Anforderungen an potentielle IT-Lösungsansätze sowie der konzeptionellen Erarbeitung, wie auch der prototypischen Umsetzung von ausgewählten Kernthemen. Im Fokus stehen eigenständig entwickelte IT-Lösungen zur Unterstützung bei Entwurfs- und Planungsarbeiten.

Intended Learning Outcomes:
Nach der erfolgreichen Teilnahme am Modul sind die Studierenden in der Lage

- Potentiale und Möglichkeiten des Einsatzes digitaler Werkzeuge für komplexe Problemstellungen im Kontext architektonischer Planungs- und Entwurfsphasen zu erkennen,
- identifizierte Problemstellung analytisch zu bearbeiten und aufbauend Anforderungen an ein IT-Konzept zu formulieren,
- eigenständiges Lösungskonzept ausgehend der definierten Anforderungen zu definieren und zu erstellen,
- relevante Konzeptbausteine zu erkennen und diese prototypisch als IT-Lösung umzusetzen,
- konzeptionelle Entscheidungen im kritischen Diskurs, aber auch programmiertechnische Fähigkeiten zu reflektierend und Gegenargumente fachkundig zu widerlegen.

Teaching and Learning Methods:
Die theoretischen Inhalte und programmiertechnische Grundlagen werden von Dozent/inn/en in Inputveranstaltung vermittelt und durch Expertinnen und Experten aus der Praxis angereichert.
Im praktischen Teil erfolgen Analyse und Erarbeitung potentieller Konzeptfelder und Bereiche in Gruppenarbeit bzw. in Workshopsessions. Die Konkretisierung der Anforderungen, das Erarbeiten eines Konzeptes, wie auch die prototypische Implementierung erfolgen in selbstständiger Bearbeitung.
Ergänzt durch selbständige Recherche von Literatur und Referenzmethoden erschließen die Studierenden nötiges Wissen und wissenschaftlich fundierte Grundlagen zur Untermauerung ihrer vorausgesagten Problemstellungen. Wöchentliche Besprechungen sowie mehrere Präsentationen im Lauf des Semesters fördern Diskurs und Reflektion zur eigenen Arbeit und bieten die Gelegenheit, die Verteidigung der Arbeit gegen Kritik einzuüben.

Media:
In dem Modul werden theoretischen Inhalte und programmiertechnische Grundlagen in Form von Vorträgen mit Projektionen gehalten. Der praktische Teil erfolgt in seminaristischer Form am PC. Die Folien der Vorträge, grundlegende Literaturquellen und Vorlagematerialien werden auf der Lernplattform der TUM zur Verfügung gestellt.

Reading List:
Lehrmaterial wird semesterweise im Internet zusammengestellt.

Responsible for Module:
Dr.-Ing. Gerhard Schubert, Dipl.-Ing. Nils Seifert

Courses (Type of course, Weekly hours per semester), Instructor:
Spezialthemen Computational Design II (Seminar, 4 SWS)
Petzold F, Förster N
For further information in this module, please click campus.tum.de or here.

Module Description

AR30382: Fast Track Design Methods | Strukturierte Planungs- und Kreativitätsmethoden

Version of module description: Gültig ab summerterm 2018

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

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

Description of Examination Method:
Die Modulprüfung setzt sich aus einer erfolgreichen Teilnahme an der Blockveranstaltung (Workshop) und einer wissenschaftlichen Ausarbeitung der in der Blockveranstaltung erzielten Inhalte zusammen. Die wissenschaftliche Ausarbeitung (Broschüre, ca. 20 Seiten je Gruppe) wird als interdisziplinären Gruppenarbeit erbracht, die in angemessenem Abstand zur Blockveranstaltungen (ca. 4-6 Wochen) in digitaler Form einzureichen ist. Anhand der Ausarbeitung wird überprüft, inwiefern die Studierenden in der Lage sind, in einer interdisziplinären Gruppenarbeit in einzelnen Arbeitsschritten und individuellen Arbeitspaketen Ergebnisse zu erarbeiten, zu visualisieren und zu dokumentieren. Die Ausarbeitung besteht aus einer Executive Summary, einer vertieften Beschreibung, Weiterbearbeitung und wissenschaftlichen Fundierung der im Workshop erarbeiteten Inhalte, einer Dokumentation der Blockveranstaltung sowie des Gruppenprozesses, und einer abschließenden Bewertung der Blockveranstaltung in ihrer Eignung für zur Kreativitäts- und Innovationsförderung. Der Fokus der Bearbeitung des Berichtes ist für die Gruppenteilnehmer auf ihre jeweilige Disziplin auszurichten. Für teilnehmende Studierende der Betriebswirtschaft ist eine betriebswirtschaftliche Schwerpunktsetzung zu den oben genannten Elementen erforderlich. In Abhängigkeit vom gestellten Thema sind die Schwerpunkte einer Markt- und Umfeldanalyse, die Formulierung eines Geschäftsmodelles mit vereinfachter Einnahme/Ausgabeaufstellung, die Entwicklung einer Umsetzungsstrategie mit Vertriebs- oder Vernetzungskanälen für die erarbeiteten Inhalte zu bearbeiten. Weitere betriebswirtschaftliche Vertiefungen können im Einzelfall vereinbart werden. Die Präsentation von Zwischen- und Endergebnissen im Rahmen der verbindlichen Präsenzveranstaltungen (Workshops) überprüft, ob die Studierenden in der Lage sind, ihr Lösungskonzept einem Fachpublikum überzeugend zu vermitteln.

Repeat Examination:

(Recommended) Prerequisites:
Voraussetzung für alle Kursteilnehmer ist Offenheit und Interesse an Zusammenarbeit in einem interdisziplinären Kontext. Das Modul ist offen für Studierende im Master und fächerübergreifend, mit Schwerpunkt ingenieurswissenschaftlicher Richtungen, insbes. Architektur.

Content:
Das Modul orientiert sich fachlich an Themen der gebauten Umwelt (Built Environment), für die interdisziplinäre Ansätze benötigt werden und eine Zusammenarbeit von ingenieurswissenschaftlicher, IT, bertriebswirtschaftlicher und architektonischer Fachrichtungen wichtig sind.
Die Themen variieren semesterweise und werden in adäquaten Formaten wie beispielsweise Design Sprint, Business Game oder Design Thinking Workshop durchgeführt. Sie beinhalten methodologisch folgende Schritte:
- Kontextanalyse für einen gegebenen Sachverhalt mit Techniken aus den Bereichen Design, Architektur, Business Management und IT,
- Ideengenerierung mit Kreativitätstechniken aus den Bereichen Design, Architektur, Business Management und IT,
- Ideenauswahl mit Bewertungsmethoden aus den Bereichen Design, Architektur, Business Management und IT,
- Prototyping mit Werkzeugen und Methoden aus den Bereichen Design, Architektur, Business Management und IT,
- Präsentationstechniken aus den den Bereichen Design, Architektur, Business Management und IT.

Intended Learning Outcomes:
Die Teilnehmer werden an aktuell in der Wirtschaft praktizierten Kreativitäts- und Innovationsmethoden (z.B. Design Sprint, Business Game, Make-/Hackathon, Design Thinking Lab) herangeführt, um komplexe Probleme, interdisziplinär, integrativ und strukturiert zu bearbeiten.
Nach der Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage,
- Kontexte der jeweiligen Aufgabenstellung (z.B. The Circular University) umfassend zu verstehen und mit visuellen Methoden sowie Werkzeugen zu analysieren,
- Methoden und Werkzeuge wie Graphic Recording, Visual Mapping, Cards, Interviews & Charttechnik kontextbezogen einzusetzen,
- komplexe Sachverhalte eigenständig zu erschließen, mittels geeigneter Methoden zu analysieren und nach Relevanz zu bewerten,
- Anforderungen abzuleiten, Problemstellungen zu formulieren und Konzeptionen und zu entwickeln,
- Präsentationsmethoden und -techniken für die jeweiligen Arbeitsschritte und Zielgruppen (potentiellen Kunden und Fachpublikum) einzuordnen und anzuwenden,
- interdisziplinäre Schnittstellenkompetenzen zu entwickeln

Teaching and Learning Methods:
Das Modul besteht aus der Vermittlung theoretischer sowie praktischer Aspekte. In Form von Vorträgen wird das notwendige theoretische Wissen von Dozent/inn/en vermittelt und durch Expertinnen/Experten aus der Praxis angereichert. In seminaristischer Form werden die Gruppen durch Dozent/inn/en in der Ausarbeitung unterstützt und angeleitet. Die Studierenden werden zum Studium der Literatur und der inhaltlichen Auseinandersetzung mit den Themen angeregt.

Media:
In dem Modul werden theoretischen Inhalte und methodische Grundlagen in Form von Vorträgen mit Projektionen gehalten. Der praktische Teil erfolgt in seminaristischer Form am Computer oder mit etablierten Mitteln. Die Folien der Vorträge, grundlegende Literaturquellen und Vorlagematerialien werden auf der Lernplattform der TUM zur Verfügung gestellt.

Reading List:
Lehrmaterial wird semesterweise im Internet zur Verfügung gestellt.

Responsible for Module:
Chantzaras, Christos; Dr.-Ing.

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

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

Module Description

AR30402: Architectural Design Thinking | Architectural Design Thinking

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:
Die Modulprüfung wird in Form einer Projektarbeit erbracht. Diese gliedert sich in 5 Arbeitspakete: Kontext & Komplexität, Problemumschreibung, Aufbau Narrativ und Bedeutung, Systemkonzept & Systementwurf und die finale Präsentation mit einzureichendem Pitch-Report. Mit den Arbeitspaketen, die anhand eines individuell gewählten Themas im „Built Environment" bearbeitet werden, weisen die Studierenden nach, dass sie eine komplexe Problemstellung formulieren, deren Kontext erfassen, strukturiert aufbereiten und Lösungskonzepte entwerfen können. Zwischen den Arbeitspaketen werden Übungen in Gruppen durchgeführt, die einzelne Fragestellungen der Vorlesungen aufgreifen. Sie werden analog, visuell, interaktiv und am Flip-Chart bearbeitet sowie präsentiert.
Jedes Arbeitspaket ist mithilfe von Flip-Chart, Projektor mit analogen und digitalen Medien zu bearbeiten und in 2 bis 5-minütigen Präsentation mit anschließender Diskussion im Plenum vorzustellen. Für die Abschlusspräsentationen sind je 10 Minuten vorgesehen. Dabei schulen die Studierenden unterschiedliche Präsentationstechniken, können ihr Kommunikationsverhalten zielgerichtet einsetzen bzw. anpassen, und im direkten Austausch Fragen, Kommentare oder Querbezüge zu den weiteren Arbeiten des Kurses diskutieren.

Die Abschlussdokumentation der Projektaufgabe wird in Form eines „Pitch-Reports" erbracht, und dient dem Nachweis, dass die durchgeführten Prozessschritte und in den Einzelpaketen erarbeitete Ergebnisse konsistent zusammengefasst werden können.

Gruppenarbeiten:
Kleinere Übungen während des Kurses in Gruppen von 3-4 Studierenden

Individualarbeiten:
5 Arbeitspakete mit Präsentation zu einem individuellen Thema während des Kurses; diese dienen als Anwendung und Weiterführung der Kursinhalte, sowie der Entwicklung eines eigenständigen Bearbeitungsschwerpunktes.

Aufgabe 1: Kontext & Komplexität Aufgabe 2: Problemumschreibung
Aufgabe 3: Aufbau Narrative und Bedeutung Aufgabe 4: Systemkonzept & Systementwurf
Aufgabe 5 / Endabgabe: Finale Präsentation mit Abgabe Pitch-Report inkl. Systementwurf und Prototypenkonzept.

Präsentation am Board, Flip-Chart, Projektor mit analogen und digitalen Medien abhängig von der zu bearbeitenden Aufgabe im jeweilig gewähltem Thema. Aufgaben 1 und 2 werden meist visuell analog bearbeitet, Aufgaben 3 bis 5 werden digtial als Präsentation, Animation oder Prototyp erstellt.

Der Pitch-Report als PDF setzt sich aus Executive Summary, visuellen und diagrammatischen Beschreibung von Kontext, Konzept, Prototypenskizze sowie Implementierungsidee und -konzept, Literatur- und Quellenverzeichnis zusammen.

Geprüft werden die Bearbeitung der jeweiligen Arbeitspakete nach Tiefe der Fragestellung und Zukunftsorientierung, nach grafischer Vermittlung, nach kritischem Hinterfragen und nach konsistenter Darstellung. Der Pitch-Report wird nach Grad des Unkonventionellen, Konsistenz, grafischer und textlicher Ausarbeitung sowie nachvollziehbar dargestellter Konzeptidee bewertet.

Repeat Examination:

(Recommended) Prerequisites:
abgeschlossenes Bachelorstudium in Architektur, Design, Nachhaltigkeit, Bauingenieurswesen

Content:
Fähigkeiten und Eigenschaften von Architekten eigen sich in besonderer Weise für die Entwicklung innovativer Ideen und nachhaltig-relevanter Konzepte in Bereichen außerhalb des klassischen Gebäudentwurfes. Während Management- und Industrial Design Thinking-Ansätze an Grenzen stoßen, radikal Neues zu entwickeln, findet sich im architektonischen Denken Potential, neue Systeme und Formen für Unternehmen und Gesellschaft zu entwerfen. Mit „Architectural Design Thinking“ können Entscheidungsprozesse in frühen Phasen von Projekten und Initiativen beeinflusst werden. Das Modul in englischer Sprache führt in Forschung und Praxis zu Design Thinking und Innovation ein und erläutert, in welchen Bereichen sich Architectural Design Thinking und Architectural Programming unterscheidet. Das Seminar zeigt auf, wie Architekten sich jenseits vom Gebäudeentwurf in Phase Null interdisziplinär mit Management, IT und weiteren Gebieten vernetzen können. Die Studierenden lernen komplexe Kontexte zu erfassen, visuell und verbal ihre Präsentationsfähigkeiten zu stärken und Konzepte zu entwickeln für ihre künftigen Aufgaben in der gebauten Umwelt. Themen sind Zukunft der Arbeit, Mobilität, Smart Cities, Nachhaltigkeit, Produktion und Digitalisierung der Bauindustrie. Sie verbinden dabei Denken und Werkzeuge der Architektur mit Ansätzen des Managements und Designs, und schließen ihre entwickelten Konzepte mit einem „Pitch-Report“ ab.

Intended Learning Outcomes:
Nach Abschluss des Moduls verstehen die Teilnehmer die Synthese-, System- und Innovationspotentiale des architektonischen Denkens. Die Studierenden sind in der Lage, Kontexte aktueller und zünftiger Herausforderungen der gebauten Umwelt umfassend zu verstehen und mit visuellen Methoden sowie Werkzeugen der Architektur zu analysieren und darzustellen (u.a. Graphic Recording, Visual Mapping, Cards, Diagrams, 3D Modelling etc.). Sie können systemisches Denken anwenden, interdisziplinäre und co-kreative Arbeitsweisen anwenden und Grundlagen der Innovationsforschung sowie des Innovationsmanagements in ihre zu entwickelnden Projekte integrieren.

Die Studierenden können nach Abschluss des Moduls komplexe Sachverhalte strukturieren, Problemstellungen hinterfragen und daraus mittels neu gelernter Methoden eigenständige und verantwortungsvolle Ideen entwickeln. Sie sind befähigt, diese in neue Konzeptionen und Lösungsansätze zu überführen, die jenseits eines Gebäudeentwurfes liegen, und Prototypenskizzen zu entwerfen. Sie können außerdem im Rahmen des Moduls vermittelte Präsentationstechniken einsetzen und ihr Kommunikationsverhalten zielgerichtet den einzelnen Arbeitspaketen anpassen. Die Studierende sind in der Lage, durchgeführte Prozessschritte und erarbeitete Ergebnisse konsistent zusammenzufassen und in eine Gesamtdokumentation als "Pitch-Report“ darzustellen.

Teaching and Learning Methods:
Der Kurs ist auf die aktive Teilnahme der Studierenden ausgelegt, die sowohl in Diskussionsrunden sowie kleineren Gruppenarbeiten Inhalte und mögliche Themenrichtungen des Kurses erarbeiten. Die Vorlesungen zu den einzelnen Arbeitspaketen wechseln sich mit den individuellen Beiträgen bzw. Präsentationen der Studierenden ab. Es wird sowohl mit Projektor und Videobeiträgen gearbeitet, als auch am Flip-Chart, mit Karten oder weiteren analog- visuellen Elementen. Die Beiträge der Studierenden werden vor den Studierenden präsentiert und diskutiert, um konstruktiv die einzelnen Individualprojekte weiterentwickeln zu können. Die Lehrmaterialien sowie weiterführende Literatur und Online-Medien werden über moodle zur Nachbereitung und Integration in die einzelnen Projekte bereitgestellt.

Media:
Folien, Blog, FlipChart, Adobe Creative Suite, Karten

Reading List:
Literaturangaben und -ausgabe während des Kurses

Responsible for Module:
Christos Chantzaras

Courses (Type of course, Weekly hours per semester), Instructor:
Architectural Design Thinking (Seminar, 4 SWS)
Chantzaras C
For further information in this module, please click campus.tum.de or here.

Module Description

AR30417: Robotic Fabrication in Architecture | Robotische Fabrikation in der Architektur [Robotic Fabrication]

Version of module description: Gültig ab summerterm 2020

Module Level: Bachelor/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 performance is provided in the form of exercise achievements.

The exercise achievements include completing a series of six predefined programming tasks to solve application-related problems using learned theoretical content. In doing so, factual knowledge and an understanding of detailed teaching content and functional relationships should be demonstrated. The exercise achievements are carried out electronically in the form of programming exercises.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge of the CAD software Rhino and Grasshopper and programming in Python is an advantage.

Content:
1. Introduction to fundamental methods of Digital Fabrication in Architecture and Construction.
2. Introduction to the software Rhino and Grasshopper, the programming language Python, as well as the Open-Source frameworks COMPAS (https://compas-dev.github.io/) and COMPAS_FAB (https://gramaziokohler.github.io/compas_fab) for the Architecture, Engineering, and Construction (AEC) sector.
3. Introduction to basic data structures for the modelling and processing of architectural geometry.
4. Introduction to basic data structures for the modelling of robot-assisted or digital manufacturing pro-cesses.
5. Overview of parametric and algorithmic design methods and their associated robotic manufacturing techniques.

6. Introduction to the basics of robot programming and interfaces.
7. Domain-specific case studies (e.g., robotic assembly of masonry, robotic 3D printing, etc.).
8. Context-dependent and individual perspectives on sustainability regarding ecological, social, and eco-nomic development.

Intended Learning Outcomes:
After successfully completing the module, students will be able to
• understand the scope and relevance of computer-aided methods for architecture and construction,
• grasp fundamental data structures for computer-aided modelling of architectural geometry,
• comprehend the theoretical background of basic data structures for the digital fabrication of buildings and building components,
• apply the basic principles of algorithmic and parametric design methods,
• implement basic versions of common algorithms related to architectural geometry and robotic fabrication,
• utilise common CAD tools as interfaces to self-implemented solutions,
• assess academic literature in the field of Digital Fabrication in Architecture with regard to scientific evidence,
• incorporate context-dependent and individual perspectives on sustainability,
• continuously reflect on the learned methods and knowledge concerning sustainable ecological, social, and economic development.

Teaching and Learning Methods:
This module is designed to deliver a comprehensive understanding of the conceptual and practical aspects of digital and robot-assisted manufacturing in architecture. The instructional approach encompasses structured lectures to convey theoretical principles, hands-on practical exercises, and tutorials. By applying fundamental examples of digital fabrication, such as the robotic assembly of masonry, students acquire knowledge in parametric modeling and digital design using the software Rhino and Grasshopper, along with the programming language Python. These foundational skills are further reinforced through a series of hands-on exercises. Interactive tutorials are integrated to guide students through the usage of essential tools and software. They provide step-by-step guidance, fostering a deeper comprehension of these tools and their relevance in architectural digital fabrication.

Media:

Reading List:
References will be provided at the beginning of the semester.

Responsible for Module:
Kathrin Dörfler kathrin.doerfler@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Robotische Fabrikation in der Architektur (supported by DesignFactory) (Seminar, 4 SWS)
Dörfler K, Atanasova L, Fleckenstein J, Krakovska E
For further information in this module, please click campus.tum.de or here.

Module Description

BGU32029: Nonlinear Finite Element Method | Nichtlineare Finite Elemente Methode [NFEM]

Version of module description: Gültig ab winterterm 2018/19

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

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

Description of Examination Method:
The final examination of this module is held as a written test (duration 90 min.). The auxiliary means for the exam can be found at the bulletin at the chair or on the chair's homepage (www.st.bgu.tum.de).

The exam consists of a combination of general questions and calculation assignments. Handling the general questions, the students are supposed to show that they have understood the fundamentals of the nonlinear finite element method. Furthermore, they are supposed to be able to judge about the reasons for geometrical nonlinearities and understand the implementation of continuum mechanics for nonlinear structures.
The latter should be applied in the calculation assignments to particular problems. Dealing with the calculation assignments the students should also show that they have the ability to develop parts of a finite element code by themselves. Additionally, it is to be demonstrated that the finite element method can be applied to nonlinear problems in structural mechanics. In this case the special mathematical methods for the solution of nonlinear problems in structural analysis are to be understood. By interpreting given load-displacement curves the students should judge about the behavior of those structures.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Firm knowledge in higher mathematics and numerical methods as well as good basic knowledge in mechanics and structural analysis. Previous knowledge in continuum mechanics is helpful but not necessary.

Content:
In the module the main concepts and fundamentals of the nonlinear finite element method are taught:

- Completely nonlinear system behavior.
- Large displacements.
- Calculation of bearing load.
- Instability problems, i.e. buckling.
- Path following methods: Load- and displacement control, arc-length method.
- Attendant eigenvalue analysis.
- Alternative strain and stress measures.
- Element formulations.
- Characteristic examples.

Intended Learning Outcomes:
At the end of the module the students have understood the basics of the finite element method. They are able to apply the finite element method to nonlinear problems in structural mechanics. In the nonlinear case students are able to assess geometric nonlinearities. Moreover, students are capable of applying continuum mechanics for the evaluation of nonlinear structures. They should also be able to understand and apply mathematical solution methods for nonlinear analysis of structures. In order to be able to judge about the behavior of nonlinear structures, load-displacement curves are utilized. Furthermore, at the end of the course students are able to develop simple finite element programs by themselves and have the capability to extend the range of applications to more complex problems concerning the finite element method using specialist literature.

Teaching and Learning Methods:
The module consists of a lecture and an exercise. The lecture contains classical presentations with script and notes. For consolidation of the content, exercises containing hand calculations and computer algebra are conducted. For further intensification of the contents additional exercise sheets (“Check your knowledge”) are provided. The topics concerning nonlinear analysis are supported by a teaching software.

Media:
Script, Presentation supported by media (PowerPoint, videos, …), notations at the blackboard, preprints, software application.

Reading List:
- Felippa ,C. A., "Introduction to Finite Element Methods" , University of Colorado at Boulder
- Hughes, T.J.R., "The Finite Element Method", 2000, Dover Publications Inc.
- Onate, E., "Structural Analysis with the Finite Element Method. Linear Statics", 2009, Springer
- Felippa, C. A., "Nonlinear Finite Element Methods", Chapters 1 to 30, University of Colorado at Boulder.
- Wriggers, P., "Nichtlineare Finite-Element-Methoden", 2001, Springer

Responsible for Module:
Prof. Dr. -Ing. Kai-Uwe Bletzinger (kub@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Nichtlineare Finite-Elemente-Methode (Vorlesung, 2 SWS)
Bletzinger K [L], Bletzinger K (Goldbach A, Singer V), Devresse B, Fußeder M, Goldbach A, Singer V

Übung zu Nichtlineare Finite-Elemente-Methode (Übung, 2 SWS)
Bletzinger K [L], Bletzinger K (Goldbach A, Singer V), Devresse B, Fußeder M, Goldbach A, Singer V
For further information in this module, please click campus.tum.de or here.

Module Description

BGU60017: Probabilistic Life Cycle Analysis and Integrity Management of Infrastructures | Probabilistische Lebenszyklusanalyse und Unterhaltsmanagement von Infrastrukturbauten

Version of module description: Gültig ab summerterm 2018

Module Level: Master	Language: English	Duration: one semester	Frequency: summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 45	**Contact Hours:** 45

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

Description of Examination Method:
The course assessment takes place as a project work. The students will solve a practical problem that requires implementation of the methods discussed in class in a computer code. The students will be evaluated based on a written project report that documents the implemented approach and obtained results. The students will present their project in a 15-minute presentation followed by a discussion of the presented solution approach. The aim of the project is that students become familiar with the concepts discussed in class through hands-on experience. The project report will assess the students' understanding of the implemented methods and their applicability to specific problems. The purpose of the presentation is to assess the students' ability to describe theoretical concepts and communicate the adopted approach to solve a practical problem in a clear fashion.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
The course will assume a basic knowledge of probability concepts such as random variables and their
description (e.g., through completion of the MSc course "Risk Analysis" or "Stochastic Finite Element
Methods"). Basic knowledge of Matlab or Python is required for the exercises.

Content:
After a short introduction in probability theory, different approaches to monitore a structure are introduced:

1. General introduction

2. Basics of reliability analysis
3. Reliability of maintained systems
4. Time value of money
5. Decision theory and cost-benefit analysis
6. Models of deterioration mechanisms
7. Repair and rehabilitation
8. Inspection and monitoring strategies
9. Life-cycle cost analysis (LCCA)
10. Optimization of inspection and monitoring strategies

Intended Learning Outcomes:
This course enables the student to understand, analyze and communicate the elements of life-cycle reliability and asset integrity management subject to uncertainty and randomness. Upon completion of the module, students will be able to:
- Understand the fundamental concepts and challenges in infrastructure asset integrity management
- Understand and evaluate life-time reliability, availability and risk
- Perform probabilistic evaluations of the life-time performance of aging infrastructures by Monte Carlo simulation
- Assess the reliability of maintained structures
- Perform cost-benefit-analyses of asset integrity management strategies
- Understand the time-value of money and its relevance in infrastructure management
- Understand probabilistic models of inspection and monitoring
- Understand the effect of repair and rehabilitation
- Perform a life-cycle cost analysis
- Optimize inspection strategies and monitoring
- Implement analysis methods in computational tools such as Python or Matlab

Teaching and Learning Methods:
The course is a 1-week (5 days) block course. It consists of lectures (50%) and exercises (50%), which implement the theory to 1-2 example structures and infrastructures.
Lectures will be given partly on the black/whiteboard and partly by presentations on slides. The whiteboard allows to develop key concepts and mathematical formulations at a pace that is conducive to a deeper understanding. The presentations on slides facilitates presentation of how these concepts apply to real systems and present case-studies.
In the exercise part, the students will be asked to solve selected exercises that are drawn from one or two case studies. These case studies will be introduced at the beginning of the course and utilized throughout. Some of the exercises will require the use of suitable software tools, such as Matlab or Python. Students will be required to develop and present the solution of selected exercises in class.

Media:
- Lectures with blackboard supported by slides
- Exercise sheets

- Matlab code examples

Reading List:
Bismut, E., Straub, D. 2022. A unifying review of NDE models towards optimal decision support. Structural Safety

Bismut, E., Straub, D. 2021. Optimal adaptive inspection and maintenance planning for deteriorating structural systems

References and selected materials will be provided

Responsible for Module:
Max Teichgräber

Courses (Type of course, Weekly hours per semester), Instructor:
Probabilistic life cycle analysis and integrity management of infrastructures (Vorlesung mit integrierten Übungen, 3 SWS)
Bismut E, Straub D
For further information in this module, please click campus.tum.de or here.

Module Description

BGU60020: Risk Analysis | Risikoanalyse [RA]

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:
The module examination consists of a Klausur (duration 90 min).

With the exam the students prove that they are able to reflect and reproduce the contents of the modul. Also the Students demonstrate that they are able to describe and reflect important theories. Throughout the semester, students are given tasks based on the lectures, as well as homework and exercises to continuously check their level of knowledge.

All study materials, literature and simple scientific calculators are permitted as aids in the exam.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The module will assume a basic knowledge of probability concepts such as random variables and their description (e.g., through completion of the BSc module "Zuverlässigkeit und Lastannahmen"). Basic Matlab knowledge is an advantage but not required (an introduction will be given).

Content:
1. Introduction, Data analysis using Matlab
2. Probability theory
3. Random variables
4. Parameter estimation
5. Probabilistic modeling of systems
6. Discrete probability models in engineering
7. Continuous probability models in engineering
8. Multivariate probability models

9. Functions of random variables
10. Monte Carlo simulation
11. Extreme value distributions
12. Random processes
13. Outlook

Intended Learning Outcomes:
Upon successful completion of this module, students are able understand concepts of uncertainty and information. Students will gain a profound toolbox for analyzing engineering problems subject to uncertainty and randomness. At the end of the course, students are able to:
- Know when to apply probabilistic methods and risk analysis
- Use the appropriate probabilistic model for individual and groups of variables
- interpret data analysis (statistics) using Matlab
- Apply Bayes rule for information updating
- Analyze the reliability of systems with statistically dependent elements
- use functions of random variables
- create stochastic process models
- Interpret the quality of a probabilistic analysis

Teaching and Learning Methods:
The module consist of weekly lectures and integrated exercises from the fields of civil, environmental, structural, and mechanical and transportation engineering.
Lectures will be given on the blackboard, including selected illustrations. Case studies should help the understanding of the problems. The lecture notes in PDF form will be distributed at the beginning of the semester.
Simple examples for hand-calculation will be provided and more realistic examples will be carried out using Matlab in the computer facilities of the department.
Short tests (15min) will be carried out during the semester, which serve to self-assess the learning success of students.

Media:
- Lectures with blackboard supported by PowerPoint
- Exercises, partly using Matlab (which is available to all TUM students)
- Lecture notes including theory and examples
- Short tests
- 2 homework examples

Reading List:
Lecture notes will be distributed. The following books provide useful supplemental material:
- Kottegoda, N. T., and R. Rosso (2008), Applied statistics for civil and environmental engineers, Blackwell, Oxford.
- Ang, A. H.-S., and Tang, W. H. (2006). Probability Concepts in Engineering: Emphasis on Applications to Civil and Environmental Engineering, Wiley, New York.

- Benjamin, J. R., and C.A., C. (1970). Probability, Statistics and Decision for Civil Engineers, McGraw-Hill, New York.
- Bedford, T., and Cooke, R. (2001). Probabilistic risk analysis: foundations and methods, Cambridge University Press.

Responsible for Module:
Herr Prof. Dr. sc. Tech. Daniel Straub straub@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Risikoanalyse (Vorlesung mit integrierten Übungen, 4 SWS)
Straub D [L], Chan J, Straub D, Teichgräber P
For further information in this module, please click campus.tum.de or here.

Module Description

BGU60024: Seminar on Elements of Machine Learning | Seminar über Elemente des Machine Learning

Version of module description: Gültig ab summerterm 2020

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 45	**Contact Hours:** 45

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

Description of Examination Method:
The course assessment takes place as a project work. The students will be assigned specific topics from the course. The students will develop an in-depth understanding of the topics, and will develop computer codes to apply the methods for solving specific problems. The aim of the project is that students become familiar with the concepts discussed in class through hands-on experience. The students will be evaluated based on a 20-minute oral presentation of the project work. The presentation will assess the ability of the students to describe theoretical concepts and strategies to implement the approaches for solving problems in a clear fashion. The oral presentation will be supported by a written report that documents the details of the implemented methods and obtained results.

Repeat Examination:

(Recommended) Prerequisites:
The seminar is intended for masters and PhD students with an interest in data analysis and machine learning. Basic knowledge of probability is required, particularly important is probability distributions and their properties. Familiarity with concepts of linear algebra, such as matrices, will be helpful. Knowledge of programming in Matlab is required.

Content:

Data analysis and machine learning are useful tools that are widely applied in science and engineering. This seminar will familiarise the participants with the basics of machine learning. The seminar consists of lectures and tutorials introducing concepts from machine learning. In the later part of the seminar, the students will present selected topics taught in the lectures. The topics to be covered include linear regression, linear classification, neural networks, support vector machines, clustering, mixture models and the expectation-maximization algorithm.

Intended Learning Outcomes:
Intended Learning Outcomes At the conclusion of this module, the students will be able to:
- formulate data analysis problems in engineering and applied science in a machine learning framework
- implement basic machine learning algorithms

Teaching and Learning Methods:
The seminar is offered as a block course consisting of 5 lectures and 5 tutorials. The lectures will introduce the basic concepts of machine learning and provide an overview of selected topics from Bishop's book. Through the tutorials, the students will learn how to implement the machine learning algorithms to solve practical problems. The lectures and tutorials will be given on black/whiteboard supported by presentations on slides. The whiteboard facilitates description of theoretical concepts and mathematical formulations at a pace that is conducive to a deeper understanding. The presentations on slides helps to explain complex concepts in a simplified manner through the use of graphical illustrations. In the second half of the course, each participant will be assigned one of the selected topics. The students will present the assigned topic, along with examples implemented in Matlab.

Media:

Reading List:
C.M. Bishop. Pattern recognition and machine learning. Springer, 2006.

Responsible for Module:
Iason Papaioannou, Oindrila Kanjilal

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

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

Module Description

BGU65009: Artificial Intelligence in Engineering | Künstliche Intelligenz im Ingenieurwesen [AIE]

Version of module description: Gültig ab summerterm 2024

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 learning outcome is confirmed by passing a 90-minute written examination. The aim of the examination is confirmation that the theoretical key concepts of machine and deep learning. Furthermore, small application tasks will assess the students ability to apply the acquired lerning outcomes. In the examination no auxilliary means are allowed.

Repeat Examination:

(Recommended) Prerequisites:
Programming skills in Python and NumPy

Content:
- Basic notions, definitions and concepts of artificial intelligence, machine learning
- Theory of probability
- K-Means clustering, decision Trees support vector machines, bagging and boosting.
- Introduction to deep learning, neural networks, and multi-layer perceptron
- Convolutional neural networks.
- Object detection networks.
- Image segmentation networks.
- Introduction to reinforcement learning.

Intended Learning Outcomes:
After attending this course, students should be capable to:
- Recall the basic notions and concepts of artificial intelligence, machine learning.
- Identify sufficient AI methods as well as to optimally select them to solve given problems in the context of engineering.

- Perform data exploratory analysis, meaningfully cleaning and formulating data, to be used in Machine Learning algorithms.
- Deploy machine learning and deep learning algorithms in the context of supervised and unsupervised learning.
- Recall the basic notions and concepts relevant to neural networks, multilayer perceptrons, convolutional neural networks and image-oriented object detection networks.

Teaching and Learning Methods:
The lectures will use power point slides and will be split into different topics. For each topic, the connection to the fundamental origins (such as neural networks in human brains) will be presented as well as its connection to the engineering domain. The students will learn to apply their knowledge on a practical problems by the means of assignment that will be performed by small teams of students.

Media:
Powerpoint, Software on private Laptop

Reading List:
Russell, Stuart J. Artificial intelligence a modern approach. Pearson Education, Inc., 2010.

Ian Goodfellow, Yoshua Bengio, & Aaron Courville (2016). Deep Learning. MIT Press.

VanderPlas, J., 2016. Python data science handbook: Essential tools for working with data. " O'Reilly Media, Inc.".

Zhang, A., Lipton, Z.C., Li, M. and Smola, A.J., 2023. Dive into deep learning. Cambridge University Press.

Responsible for Module:
Stavros Nousias (stavros.nousias@tum.de) André Borrmann (andre.borrmann@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Artificial Intelligence in Engineering (Vorlesung, 2 SWS)
Nousias S, Du C
For further information in this module, please click campus.tum.de or here.

Module Description

BGU65015: BIM.project | BIM.project [BIM.project]

Version of module description: Gültig ab winterterm 2021/22

Module Level:	Language:	Duration:	Frequency:
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 125	**Contact Hours:** 55

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

Description of Examination Method:
The proof of proficiency takes the form of a project completed by the students in small interdisciplinary groups (3-5 participants from different study courses). Within the project framework, the students independently develop a building design according to the task presented at the beginning of the semester. The task includes various subject areas for which an individual group member is primarily responsible. With the help of the project work, it is to be tested whether the students can implement the design requirements and independently design a building with the BIM method, taking into account the task's boundary conditions.
To test the students' communicative skills in presenting scientific topics to an audience, the project's progress is documented in two presentations. Within the presentation, the students present their results in groups. In addition, a final presentation will take place at the end of the project period, in which the written elaboration of the project work will be presented. The written submission consists of a detailed brochure (approx. 15 - 30 pages) and a poster giving an overview of the design. In addition to a description of the designed structure, the elaboration should also include the software tools used, the calculation results and a critical examination of one's design with regard to the implementation of Building Information Modelling. Furthermore, the model checking competence is tested in the students' examination of an external model. For this purpose, the students check the model of another group with suitable BIM software (model checking in a peer review procedure).
The module grade comprises the project (60% written submission, 10% peer review performance) and the associated final presentation (30%). The above-mentioned individual subject areas ensure the individual assessment of the students.

Repeat Examination:

(Recommended) Prerequisites:
BGU65016 (BIM.fundamentals)

Content:
The project addresses information technologies in the context of architecture, civil engineering and sustainable construction. It deals primarily with practical aspects to enable future engineers to integrate digital tools into the work process and critically question them. Through changing tasks, the students are encouraged to break new ground and design solutions.

The following topics are covered:
- Methods of presentation and communication of designs in civil engineering, architecture and sustainable construction
- Decision support, e.g. calculation, analysis and simulation methods
- Digital fabrication
- Building Information Modelling including methods and formats of data exchange and collaborative data management
- Further contents of civil engineering, architecture and sustainable construction that are necessary to solve the design task
- Special BIM technologies that are necessary to solve the design task

Intended Learning Outcomes:
After participating in the module courses, students can
- understand and implement a design task
- independently design a building using the BIM method
- present their design and defend and justify it in case of critical questions
- illustrate their design in a structured manner within the framework of the written work
- critically evaluate a design themselves

Teaching and Learning Methods:
The module consists of a seminar. In the seminar, still unknown basics related to the task are taught utilizing additional research on literature, information technology and computer-aided methods. Besides the basics, project aspects are also discussed with the students.
To a large extent, the completion of the task is done in independent group work. The groups are interdisciplinary and consist of students from different degree programmes: Civil Engineering, Architecture, Computer Science Environmental Engineering, Resource Efficient and Sustainable Building. The list is not exhaustive.
Weekly meetings and events are offered within the framework of the seminar. Here the students receive feedback on their work progress.
During the semester, two presentations take place as part of the seminar, in which the students present their interim status to their fellow students. This allows the students to prepare for the graded final presentation. A feedback session follows the presentations to allow for critical discourse and reflection on their work. The presentation of the work requires the students to present their ideas using concrete media, shows them whether these media are suitable for conveying their ideas, and gives them an overview of the approaches to solutions and forms of presentation chosen by the other groups.

Media:
Blackboard, PowerPoint presentations, various BIM software (incl. data exchange platform). BIM software (incl. data exchange platform)

Reading List:
"Borrmann et al. Building Information Modeling Technology Foundations and Industry Practice. 2018

Eastman et al. BIM handbook: A guide to building information modeling for owners, managers, designers, engineers and contractors. 2011."

Responsible for Module:
Prof. Dr.-Ing. André Borrmann

Courses (Type of course, Weekly hours per semester), Instructor:
BIM.project (Seminar, 4 SWS)
Borrmann A, Petzold F, Memis I, Forth K, Esser S, Heise I, Pfitzner F
For further information in this module, please click campus.tum.de or here.

Module Description

BGU65018: BIM.infra | BIM.infra [BIM.infra]

Version of module description: Gültig ab summerterm 2024

Module Level: Master	**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:
The module performance consists of a project assignment, which is assessed through a Moodle E-test and an oral submission discussion. The project assignment involves the design of a BIM model of an infrastructural asset (e.g., a road) considering given boundary conditions. The model is independently developed and created using suitable software programs throughout the semester. Through the project assignment, students demonstrate their understanding of the learned concepts and methods of Building Information Modeling (BIM) in the field of transportation engineering, recognizing common use cases and being able to reproduce and work on them independently. Additionally, students demonstrate within the project assignment their ability to use the learned concepts and methods for structured analysis and reflection of engineering problems to develop individual solution concepts.

In the Moodle e-test, students demonstrate their understanding of the conveyed terms and concepts and their ability to adequately assess circumstances in the context of Building Information Modeling for infrastructure construction.

During the submission discussion, students present the results of the project assignment and explain their approach regarding practical software application issues and the constraints of the chosen design model. This demonstrates the student's ability to explain their work steps comprehensibly and to answer and discuss technical questions regarding the choice and application of the software. The oral submission discussion should be at most 30 minutes. Ideally, the e-test and submission discussion take place on the same day.

Repeat Examination:

(Recommended) Prerequisites:
Students need to have basic knowledge of digital planning tools (CAD) and experience in building design and mathematical verification (Civil Engineering BGU65010T2, Architecture AR20039). Furthermore, confident handling of computers is helpful (office applications, internet, etc.).

Content:
The module covers various aspects of Building Information Modelling in transport:
• BIM use cases
• Data management and data exchange
• Modelling of infrastructure routes
• Quantity and cost calculation
• Sound and noise protection analyses
• Construction sequence planning and collision analyses

Intended Learning Outcomes:
The students learn the fundamental aspects of creating and evaluating client information requirements (AIA) and BIM execution plans (BAP) in BIM projects in transport infrastructure construction. The students are familiar with the BIM process and can classify the requirements of various specialist trades in the process. The students also have application-oriented knowledge of industry-standard data exchange formats and software products. Besides, the students can practically use these software products and thus develop solutions for various BIM-based planning tasks in traffic route construction.

Teaching and Learning Methods:
The course consists of a lecture and an exercise. The lecture events serve to convey theoretical knowledge. In the tutorial, software examples are presented, and the students are given the opportunity to deepen their knowledge independently on the computer with the help of exercises.

During the semester, the students work independently on a project in Building Information Modelling (BIM) in traffic route construction. This project enables the students to apply the essential concepts to problems during the current semester. The students do the work outside of the attendance hours.

Media:
Lecture and exercise with PowerPoint presentations, blackboard writing and software examples on the computer

Reading List:
Borrmann et al. Building Information Modeling - Technologische Grundlagen und industrielle Praxis. 2021

Sacks, R., Eastman, C., Lee, G., & Teicholz, P. (2018). BIM handbook: A guide to building information modeling for owners, designers, engineers, contractors, and facility managers. John Wiley & Sons.

Responsible for Module:
André Borrmann (andre.borrmann@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
BIM.infra Übung (Übung, 2 SWS)
Appelt V, Esser S, Heise I

BIM.infra (Vorlesung, 2 SWS)
Appelt V, Esser S, Heise I
For further information in this module, please click campus.tum.de or here.

Module Description

BGU69002: Remote Sensing - Advanced Methods | Fernerkundung - Vertiefte Methoden

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
The learning outcomes are examined within a parcours, consisting of
- a written exam of 60 minutes length
- a presentation of about 10 minutes.
The presentations will be given after the written exam in the classroom.

While the written exam is supposed to examine a general understanding of the topics SAR remote sensing, hyperspectral remote sensing, and atmospheric remote sensing, the presentation confirms a deeper involvement in a special topic from the overall field of remote sensing. It is meant to examine to what extent the students are capable of explaining technical, task-oriented solutions within a discourse among peers with foundation both in theory and methodology.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in photogrammetry, mathematics and physics.
Successful participation in the module Introduction to Photogrammetry, Remote Sensing and Digital Image Processing (BGU48036).

Content:
The module consists of a lecture, an exercise course and a seminar course. While the lecture provides the necessary background knowledge, exercises and seminar enable problem-oriented learning.

Remote Sensing - Advanced Methods (Lecture and Exercise):
- Along-Track and Across-Track Interferometry

- Differential SAR Interferometry
- Persistent Scatterer Interferometry
- Remote Sensing of the Atmosphere
- Hyperspectral Remote Sensing

The interferometric processing of SAR data is trained in tutorials.

Seminar Remote Sensing
- deep insight into specific and selected topics of current remote sensing research

Intended Learning Outcomes:
After the successful conclusion of the module, the students are able
- to understand and apply methods of signal processing in remote sensing
- to evaluate the usability of specific remote sensing methods for practical problems
- to analyze autonomously tasks in the research field of remote sensing
- to prepare methodical basics for a selected research topic
- to evaluate alternative approaches in practice and to develop own solutions
- to present the elaborated results in a report and/or talk

Teaching and Learning Methods:
The module is comprised of a lecture, a corresponding exercise course and a seminar. In the lecture, the content will be conveyed by presentations and the content is then consolidated by exercises. In the seminar, the basics conveyed by the lecture are applied by self-reliant work on a recent research topic, as well as by presentation and discussion of the achieved results.

Media:
Slides, lecture notes, exercise sheets, white-/blackboard

Reading List:
Remote Sensing - Advanced Methods:
- Fletcher, Karen: InSAR Principles - Guidelines For SAR Interferometry Processing and Interpretation. ESA, 2007

Seminar Remote Sensing:
- selected literature (such as scientific papers) will be provided for each topic individually

Responsible for Module:
Prof. Dr.-Ing. habil. Xiaoxiang Zhu

Courses (Type of course, Weekly hours per semester), Instructor:
Lab for Remote Sensing - Advanced Methods (Übung, 1 SWS)
Zhu X

Remote Sensing - Advanced Methods (Vorlesung mit integrierten Übungen, 2 SWS)

Zhu X [L], Zhu X

Seminar Fernerkundung (Seminar, 2 SWS)
Zhu X [L], Zhu X
For further information in this module, please click campus.tum.de or here.

Module Description

BV010010: Advanced Finite Element Method | Weiterführende Themen der Finite Elemente Methode [AFEM]

Version of module description: Gültig ab winterterm 2018/19

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

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

Description of Examination Method:
The module is finalized by a project work. The student projects are supposed to be done in small groups. The students should show that they are able to develop and implement finite elements in a team. This gives the students the ability to judge about the solutions of other finite element codes and to apply even complex finite element formulations in a purposive way. In a short report (about ten to 20 pages) about their project students should evaluate and analyze dedicated element types concerning their weaknesses and strengths. The results should be presented (duration about 20 min.) in a comprehensible way at the end of the project.

The auxiliary means for the exam can be found at the bulletin at the chair or on the chair's homepage (www.st.bgu.tum.de).

Repeat Examination:

(Recommended) Prerequisites:
A module containing the basic background of the finite element method. Very good knowledge in higher mathematics, numerical methods and basic knowledge in continuum mechanics (BV020001 Continuum Mechanics).

Content:
In the following the core content of the module is listed:
- Structures subjected to bending 1: A linear und straight Timoshenko beam element.
- Structures subjected to bending 2: Shear deformable plate elements.
- Locking phenomena and their reasons,
- variational formulation of finite elements,
- alternative finite element formulations,

- error estimation and adaptivity.

The contents are complemented by varying topics each semester.

Intended Learning Outcomes:
At the end of the module the students have an engrossed background knowledge of finite element formulations. They can analyze and evaluate dedicated element types concerning their numerical problems. On this basis the students are able to apply even complex element formulations in a purposive way. Furthermore, students should be able to develop and implement finite elements by themselves. This should give the students the possibility to judge about the commercial multi-purpose finite element programs.

Teaching and Learning Methods:
The module is based on a lecture and an exercise part. The lecture consists of classical presentations with script and notes. For consolidation of the content, exercises containing hand calculations and computer software are conducted.

Media:
Manuscript, PowerPoint, notes on the black board and software applications.

Reading List:
- Hughes, T.J.R., "The Finite Element Method", 2000, Dover Publications Inc.
- Bathe, K.-J., "Finite Element Procedures", 1995, Prentice Hall; auch in deutscher Übersetzung bei Springer erhältlich: "Finite-Elemente-Methoden"
- Onate, E., "Structural Analysis with the Finite Element Method. Linear Statics", 2009, Springer

Responsible for Module:
Prof. Dr. -Ing. Kai-Uwe Bletzinger (kub@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Seminar zu Weiterführende Themen der Finite-Elemente-Methode (Seminar, 2 SWS)
Bletzinger K [L], Apostolatos A, Fußeder M, Goldbach A, Singer V

Weiterführende Themen der Finite-Elemente-Methode (Vorlesung, 2 SWS)
Bletzinger K [L], Apostolatos A, Fußeder M, Goldbach A, Singer V

Kolloquium zu Weiterführende Themen der Finite-Elemente-Methode (Kolloquium, 1 SWS)
Bletzinger K [L], Bletzinger K, Apostolatos A, Goldbach A
For further information in this module, please click campus.tum.de or here.

Module Description

BV030004: Software Lab | Software Lab

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:

The module examination consists of a project work in a team, including the presentation of the project work. The topics of the project work are distributed according to the students' preferences and are based on current problems in industry and research and are worked on independently by the students.

The project includes the familiarization with the problem, if necessary a literature research, the choice and implementation of the solution approach in a software product. Partly the software implementation includes the familiarization with already developed software modules or the connection to commercial software products.

The module grade consists of the evaluation of two intermediate presentations, a final presentation a scientific poster, the source code of the developed software as well as its written documentation and the evaluation of the ability to work in a team in the supervised meetings. The progress of the work is documented in two presentations in which the students present their results in groups.
In addition, the quality of the poster will be evaluated in a final presentation at the end of the project period, in which the poster will also be presented. Finally, the software projects and the documentation will be evaluated. The weighting of the individual sub-grades is 10% for each intermediate presentation, 10% for the final presentation, 10% for the report and poster, 10% for the organization, 50% for the documented code.

With the help of the presentations, it should be demonstrated that the students have understood the theoretical concepts underlying their project and are able to apply and evaluate these concepts in a structured way to the problem at hand (problem-solving skills). Furthermore, the students should present the progress at the beginning, middle and end of your project and thus show additional competences in presentation techniques. Checking the progress during the presentations motivates the methodical "soft" competences of software development in several phases (e.g. agile methods).

The final presentation, including posters and question and answer sessions at the end of the presentations, will check whether the students are able to present their results comprehensively and according to scientific standards. Students work on their work independently outside of the attendance phase. In addition, the students should show that they have understood basic and advanced programming concepts and are able to implement them.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Recommended prerequisites for successful participation are basic engineering informatics, e.g. in the modules 'Bau- und Umweltinformatik I (BGU65004)' and 'Bau- und Umweltinformatik II (BGU44011)'. Students should be able to understand and use the basics of a programming language (data types, control structures, functions). In addition, an understanding of common software development methods, for teamwork in software, data security and time management is helpful (such as module BGU44013T2).

Content:
Coordination, development and testing of software for problems from engineering practice and/or problems of scientific relevance in teams (3 students). The assigned problems are either part of active research or originate from developments in industry. Team and project is supervised and supported by close cooperation with industry partners and/or research groups. Each project includes fundamental training, literature research, software development and frequent scientific reviews/presentations about the project's progress.

Intended Learning Outcomes:
Participants of this module have practical experience in the conception, implementation, and interpretation of computer-aided solutions for problems from engineering and science, including design and application of engineering software. They are familiar with interdisciplinary problems and the coordinated work in international project teams.

Teaching and Learning Methods:
The module consists of a practical training, consiting of group meetings with the project supervisors and three presentation dates including discussion. In the group meetings, the theoretical foundations of the project task are taught by the supervisors and references are given to appropriate literature sources. Furthermore, project progress will be checked regularly, new work packages will be set up and open questions answered. Implementation of the work packages is then performed independently by the students outside the attendance period. The students participate in the lectures both as presenters and as an audience. They are required to communicate their project status in a clear and understandable way and to lead constructive discussions about the presented contents.

Media:
Students present & discuss the progress of each project in three plenary sessions distributed over a two-semester working period.

Reading List:
Overall:
John Sonmez - Soft Skills: The software developer's life manual
Agile Software Development, Principles, Patterns, and Practices - Robert C. Martin

Further Literature is provided problem dependent by your supervisor

Responsible for Module:
Prof. André Borrmann

Courses (Type of course, Weekly hours per semester), Instructor:
Software Praktikum / Software Lab (Seminar, 2 SWS)
Borrmann A, Vega Torres M, Esser S, Forth K, Holla V, Kollmannsberger S, Pfitzner F
For further information in this module, please click campus.tum.de or here.

Module Description

BV030012: Engineering Databases | Datenbanken für Ingenieure [EngDB]

Version of module description: Gültig ab winterterm 2018/19

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

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

Description of Examination Method:
In the 60-minute exam the students have to demonstrate that they understand and are able to repeat the basic working principles of database theory within a limited timeframe. Additionally, they have to identify solutions and their implementations to technical application problems under time pressure accurately.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic programming skills.

Content:
This module includes the following topics:
- Conceptual database design
- Relational algebra
- Query language SQL
- Normalization
- Transactions
- Indexing
- Engineering applications

Intended Learning Outcomes:
After completion of the module the students are able to:
- create a conceptual database design using the entity-relationship model;
- apply relational database theory;
- use the query language SQL;

- normalize a relational database schema;
- understand indexing structures;
- use databases for engineering applications.

Teaching and Learning Methods:
The teaching results of the module are achieved by multiple coordinated components. The lectures are supported by PowerPoint presentations, blackboard scripts and movies illustrating computer simulations. The lecture contents are completed by exercises in the lecture hall.

Media:
Moodle e learning platform, presentations

Reading List:
Elmasri, R. Navathe, S.B. (2015): Fundamentals of Database Systems. 7th Edition, Pearson.

Responsible for Module:
Alex Braun (alex.braun@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Datenbanken für Ingenieure (Vorlesung, 2 SWS)
Mehranfar M, Mafipour M, Du C
For further information in this module, please click campus.tum.de or here.

Module Description

BV320007: Isogeometric Structural Analysis and Design | Isogeometrische Analyse und Entwurf von Strukturen [IGA]

Version of module description: Gültig ab winterterm 2018/19

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:
At the end of the module is graded by a written exam (duration 90 min.). This exam consists of general questions and calculation assignments. Answering the general questions, the students are supposed to show, that they have understood modelling and design as well as the geometric representation of shapes and the basic idea of IGA. Die calculation assignments are meant to check if the NURBS based finite element method for linear structural analysis and the Kirhhoff-Love-Theory have been understood. Furthermore, in the calculation assignments the students should show that they have the ability to model shells and multi-patch structures.

The auxiliary means for the exam can be found at the bulletin at the chair or on the chair’s homepage (www.st.bgu.tum.de).

Repeat Examination:

(Recommended) Prerequisites:
Good knowledge in higher mathematics and numerical methods, as well as sound knowledge in structural mechanics, structural analysis and the finite element method (BGU32028 Introduction to Finite Element Methods).

Content:
The module contains the following contents:

- Design modeling and "geometrical form",
- Differential geometry and computational modeling of curves and surfaces,
- Isogeometric Analysis (IGA): basic idea,
- NURBS-based FEM for linear elastostatics,

- Free-form shell structures: Kirchhoff-Love-theory,
- Nonlinear isogeometric shell element formulation,
- Modeling aspects for IGA of shells & multipatch structures,
- Integration of analysis and design - "Analysis-suitable Geometry",
- Isogeometric shape optimization.

The contents may be adjusted due to the progress in science.

Intended Learning Outcomes:
After attending the module, the students have understood the basic concepts of the isogeometric analysis and its application in numerical simulations of freeform structures and are also able to apply them. Furthermore, the students are able to understand the coherence between structural analysis and freeform structures and can evaluate its influence on the design process.

Teaching and Learning Methods:
The module is based on a lecture and an exercise part. The lecture consists of classical presentations with script and notes. For a better understanding of the contents examples are discussed.

Media:
Manuscript, presentation supported by media (PowerPoint, videos, etc.), notes on the black board and preprints.

Reading List:
- Wüchner, R., Manuskript "Isogeometric Structural Analysis and Design"
- Cottrell, J.A., Hughes, T.J.R., Bazilevs, Y., "Isogeometric Analysis", 2009, Wiley
- Kiendl, J., "Isogeometric Analysis and Shape Optimal Design of Shell Structures", 2011, TU München

Responsible for Module:
Prof. Dr. -Ing. Kai-Uwe Bletzinger (kub@tum.de) Dr.-Ing. Ann-Kathrin Goldbach

Courses (Type of course, Weekly hours per semester), Instructor:
Kolloquium zu Isogeometrische Analyse und Entwurf von Strukturen (Kolloquium, 1 SWS)
Bletzinger K [L], Goldbach A

Isogeometrische Analyse und Entwurf von Strukturen (Vorlesung, 2 SWS)
Bletzinger K [L], Goldbach A, Meßmer M
For further information in this module, please click campus.tum.de or here.

Module Description

BV320010: Introduction to Finite Element Method | Einführung in die Finite Elemente Methode [IFEM]

Version of module description: Gültig ab winterterm 2018/19

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 final examination of this module is held as a written test (duration 90 min.).
The exam consists of a combination of general questions and calculation assignments. Handling the general questions, the students are supposed to show that they have understood the fundamentals of the finite element method. Dealing with calculation assignments the students should also show that they have the ability to develop parts of a finite element code by themselves. Additionally, it is to be demonstrated that the finite element method can be applied to linear problems in structural mechanics.

The auxiliary means for the exam can be found at the bulletin at the chair or on the chair's homepage (www.st.bgu.tum.de).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Firm knowledge in higher mathematics and numerical methods as well as good basic knowledge in mechanics and structural analysis.

Content:
In the module the main concepts and fundamentals of the finite element method are taught:

- Direct Stiffness Method,
- finite element modelling,
- variational formulation of the Finite Element Method,
- finite Elements for plates in membrane action,
-isoparametric element concept,

- convergence behavior of finite element calculations / Convergence requirements,
- introduction onto locking and finite element technology,
- implementation aspects,
- finite elements for structural dynamics.

Intended Learning Outcomes:
At the end of the module the students have understood the basics of the finite element method. They are able to apply the finite element method to linear problems in structural mechanics. Furthermore, at the end of the course, students are able to develop simple finite element programs by themselves and have the capability to extend the range of applications to more complex problems concerning the finite element method using specialist literature.

Teaching and Learning Methods:
The module consists of a lecture and an exercise. The lecture contains classical presentations with script and notes. For consolidation of the content, exercises containing hand calculations and computer algebra are conducted. For further intensification of the contents additional exercise sheets (“Check your knowledge”) are provided.

Media:
Script, Presentation supported by media (PowerPoint, videos, etc.), notations at the blackboard, preprints and software application.

Reading List:
- Felippa ,C. A., "Introduction to Finite Element Methods" , University of Colorado at Boulder
- Hughes, T.J.R., "The Finite Element Method", 2000, Dover Publications Inc.
- Onate, E., "Structural Analysis with the Finite Element Method. Linear Statics", 2009, Springer

Responsible for Module:
Dr.-Ing. Ann-Kathrin Goldbach

Courses (Type of course, Weekly hours per semester), Instructor:
Kolloquium zu Einführung in die Finite-Elemente-Methode (Kolloquium, 1 SWS)
Goldbach A

Einführung in die Finite-Elemente-Methode (Vorlesung mit integrierten Übungen, 4 SWS)
Goldbach A [L], Bletzinger K, Devresse B, Fußeder M, Goldbach A, Grabke S, Singer V
For further information in this module, please click campus.tum.de or here.

Module Description

BV470009: Professional Applications of Geoinformatics | Anwendungen der Geoinformatik aus der Praxis

Version of module description: Gültig ab winterterm 2021/22

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 55	**Contact Hours:** 35

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

Description of Examination Method:
The expected learning outcomes are verified by a project work which is carried out in small groups. The assessment is done on the basis of a written project reports and an oral presentations. The reports and presentations are appropriate to assess the competencies to analyse complex GIS projects from professional practice.
The written report serves in assessing the ability of the students to summarize results typically expected from consulting services.
The oral presentation is used to assess the communication competencies in presenting process analysis results in front of an audience. The presentation and the written report are prepared in the self-study hours. Weekly meetings are scheduled with the supervisors.

Note in view of the limitations on university operations as a result of the CoViD19 pandemic: If the basic conditions (hygiene, physical distance rules, etc.) for a classroom-based examination cannot be met, the planned form of examination can be changed to a written or oral online examination in accordance with §13a APSO. The decision about this change will be announced as soon as possible, but at least 14 days before the date of the examination by the examiner after consultation with the board of examiners of the respective study program.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Prerequisites are fundamentals in Geoinformatics as coverd by the modules "Spatial Data Management and Visualisation" and "Spatial and Semantic Modeling of the Environment" of the Master program Geodesy and Geoinformation and the module "Geoinformatics" of the Bachelor program Geodesy and Geoinformation.

Content:
The module focuses on imparting competences for analysing GIS-based processes from application domains like power supply, environmental monitoring, agriculture, city and infrastructure planning, production of geospatial base data (e.g. 3D city models, geotopography).

Intended Learning Outcomes:
After successful completion of the module students are able to:
- analyse selected GIS-based processes from professional practice (data models, GIS functions, accuracy reqirements, interfaces, system architecture),
- adequately present the results of the process analysis.

Teaching and Learning Methods:
Presentations by experts from professional practice and working in small groups are used as teaching and learning methods. Each student is expected to familiarize him/herself independently with one of the GIS-based processes presented by an external expert. The result of the process analysis is presented by the student by giving an oral presentation and a documentation in written form.

Media:
- presentations,
- use cases and solutions,
- GIS and DBMS software.

Reading List:
provided by the lecturers/supervisors

Responsible for Module:
Prof. Thomas Kolbe

Courses (Type of course, Weekly hours per semester), Instructor:
Ausgewählte GIS-Projekte (Vorlesung, 3 SWS)
Kolbe T, Beil C, Buziek G
For further information in this module, please click campus.tum.de or here.

Module Description

BV530017: Practical Course in Engineering Surveying | Praktikum Ingenieurvermessung

Version of module description: Gültig ab summerterm 2018

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 45	**Contact Hours:** 45

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

Description of Examination Method:
Examination consists of a final report to be marked. In it, students show their structural project planning, researched background information, procedure, calculations and results. By this, the report reflects all project steps and allows a clear assessment of each step's quality.
When working in groups, a corporate report is possible, as well as individual reports on the students' choice. In the latter case, individual efforts have to be indicated.
Unsufficient projects may not be repeatedly examinated; in this case another project topic has to be chosen and worked out.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in engineering surveying and – depending on the chosen topic – in further geodetic basic fields are required. These can, e.g., be obtained in the bachelor modules of "geodesy and geoinformatics".

Content:
- Self-contained development of procedures and results
- Links to neighbored geodetic fields and topics
- Planning and use of geodetic tools and methods
- Evaluation of data using geodetic software
- Creation of well-designed reports

Intended Learning Outcomes:
After participation in this module students are able to evaluate an engineering surveying task and deduce necessary working steps, to plan these working steps and realize them in a structured way and to show results precisely and to create a meaningful report.

Teaching and Learning Methods:
The modul consits of a supervised prpject work, which is an individual or group work (depending on the topic).
Students perform research, calculations, practical measurements and report creation mostly independent and get supervised by their tutors on demand, who also show possibilities for improvement.

Media:

Reading List:
is provided dependent on topic

Responsible for Module:
Prof. Christoph Holst

Courses (Type of course, Weekly hours per semester), Instructor:
Praktikum zu Ingenieurvermessung (Praktikum, 3 SWS)
Abdelgafar O
For further information in this module, please click campus.tum.de or here.

Module Description

BV550017: Sustainable Real Estate Development | Nachhaltige Immobilienentwicklung [Nachh_ImmoPE]

Version of module description: Gültig ab summerterm 2019

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

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

Description of Examination Method:
The examination consists of a test (eventually as remote online exam) where the students prove not only their understanding of the learning content but also their ability to apply the methods, evaluate the results and consequences and moreover to develop the given approaches for further fields of utilization. Auxiliary materials are not admissible. The test requires partly the student's own formulations, partly the qualifiedly checking of predefined statements.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
Real Estate Project Development:
Fundamentals of Real Estate Investment, Market, Terms, Phases, Types of Property; Cost Effectiveness; Site and Market Analysis,Market Participants; Sensitivity Analysis; Real Estate Evaluation and Funding, Property Value, Profitability, Market Value; Facility Management, Legal Foundations;

Value and Valuation Methods of Property:
Determination of market value of real estate, Definition of terms of value, Determination of market value according to § 194 BauGB
International methods of market value determination, Direct Value Comparison Method, Investment Method, Depreciated Replace-ment Cost Method, Residual Method, Profits Method

Intended Learning Outcomes:
Having successfully completed the module the students will have understood the given learning content and will be able to apply and develop this further. Therewith, they know to analyze and evaluate applicable situations and solve respective problems when later professionally working.

Teaching and Learning Methods:
The learning content is taught via lectures. Partly integrated supervised exercises and tutorials allow deepening this with the help of examples in interaction with the students. References to professional practice are maintained also by contributions of guest lecturers.

Media:
Lecture notes, power point-presentations, partially use of black/whiteboard, videoclips

Reading List:
Geltner, Miller, Clayton, Eichholtz, Commercial Real Estate, 3rd Edition, International Edition, OnCourse Learning, 2014
William B Brueggeman, Fisher Jeffrey, Real Estate Finance & Investments. 15th Edition
Kleiber, W. / Simon, J.: Verkehrswertermittlung von Grundstücken 7. Auflage Köln, 2007

Responsible for Module:
Prof. Dr. Bing Zhu (bing.zhu@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Immobilienprojektentwicklung- Project Development (Vorlesung mit integrierten Übungen, 2 SWS)
Zhu B [L], Zhu B

Immobilienwert und Wertermittlungsmethoden (Vorlesung mit integrierten Übungen, 2 SWS)
Zhu B [L], Zhu B
For further information in this module, please click campus.tum.de or here.

Module Description

BV550018: Seminar Advanced Real Estate Investment | Seminar Immobilieninvestition [SemImmoInv]

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:** 150	**Contact Hours:** 30

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

Description of Examination Method:
The examination consists of a a written test (duration: 60 minutes) (eventually as remote online exam) where the students prove not only their understanding of the learning content but also their ability to apply the methods, evaluate the results and consequences and moreover to develop the given approaches for further fields of utilization. Auxiliary materials are not admissible. The test requires partly the student's own formulations, partly the qualifiedly checking of predefined statements.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Module Sustainable Real Estate Development (BV550017)

Content:
Final seminar of majoring Real Estate Development discussing actual subjects from the Real Estate business based on selected scientific literature like research reports, Ph.D.-theses and other scientific papers.

Exemplary subjects:
Analysis of Real Estate Markets, Real Estate Cycle, Capital Asset Pricing Model, Hypothecary Credits / Mortgage, Joint Venture and Mezzanine-Financing, Capital Structure of Real Estate Projects, Options of Development and Land Value

Intended Learning Outcomes:
Having successfully completed the module the students will have understood the given learning content and will be able to apply and develop this further. Therewith, they know to analyze and evaluate applicable situations and solve respective problems when later professionally working.

Teaching and Learning Methods:
The module is taught as a seminar comprising lectures on the learning content as well as seminar-like discussions. The independent elaboration of respective subjects based on the study of recent scientific articles by the students on their own beyond the time of presence is projected as an essential element of the module.

Media:
Scientific literature, power point-presentations, partially use of black/whiteboard, videoclips, excursions

Reading List:
Scientific literatur representing the recent state of research

Responsible for Module:
Prof. Dr. Bing Zhu (bing.zhu@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Seminar Immobilienwirtschaft - Seminar Real Estate (Seminar, 2 SWS)
Zhu B
For further information in this module, please click campus.tum.de or here.

Module Description

BV550023: Lecture, Real Estate Management | Seminarvortrag Immobilienentwicklung [SemV_Immo]

Version of module description: Gültig ab summerterm 2019

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

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

Description of Examination Method:
The examination consists of an elaboration of a complex subject from Real Estate Development and the presentation of the results where the students prove their ability to analyse and evaluate respective situations and problems and furthermore develop the learning content for a given context.

Repeat Examination:

(Recommended) Prerequisites:
none

Content:
Elaboration and presentation of a complex subject in the field of real estate investment/ development. Due to the fact that the number of participants is limited, your registration will only be valid after receiving our confirmation email.

Intended Learning Outcomes:
Having successfully completed the module the students will have understood the given learning content and will be able to apply and develop this further. Therewith, they know to analyze and evaluate applicable situations and solve respective problems when later professionally working.

Teaching and Learning Methods:
The module comprises a supervised independent elaboration of a complex project which is to be finally presented and discussed with scientists and professionals.

Media:

Reading List:

Responsible for Module:
Prof. Dr. Bing Zhu (bing.zhu@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Seminarvortrag Immobilienentwicklung (Vorlesung, 2 SWS)
Zhu B
For further information in this module, please click campus.tum.de or here.

Module Description

BV650002: Advanced Topics in Building Information Modeling | Advanced Topics in Building Information Modeling [BIM.advanced]

Version of module description: Gültig ab summerterm 2018

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 45	**Contact Hours:** 45

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

Description of Examination Method:
25-minute presentation in which a special, selected topic from the area of "Building Information Modeling" or "Virtual design and construction" will be discussed in depth. In a 5-minute round, the students then answer the questions of the lecturers and their fellow students. Based on the basic knowledge of the Building Information Modeling course and independent research work, students should be able to demonstrate a deeper understanding of the subject matter.

Repeat Examination:

(Recommended) Prerequisites:
completion of the course "Building Information Modelling"

Content:
Current research topics in Building Information Modeling and Virtual Design and Construction. Joint presentations and discussions of current scientific publications.

Intended Learning Outcomes:
After completing the module the students will be able to:
- understand and analyse current scientific publications on Building Information Modeling and to carry out independent research work in this area of expertise
- perform scientific research in the area of Building Information Modeling

Teaching and Learning Methods:
The students choose from a list of suggested topics. They study current publications in the respective domain and present their results in a comprehensive oral presentation. This is followed by a joint round in which the results are discussed and interpreted.

Media:
Blackboard, Powerpoint Presentations

Reading List:
Eastman et al.: BIM Handbook - A guide to Building Information Modeling

Responsible for Module:
Alex Braun, alex.braun@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
BIM.advanced - Ausgewählte Themen des Building Information Modelings (Seminar, 2 SWS)
Forth K, Memis I, Borrmann A, Esser S, Petzold F, Pfitzner F
For further information in this module, please click campus.tum.de or here.

Module Description

ED110002: Geodetic Engineering and Consulting | Geodetic Engineering and Consulting

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
The targeted learning outcomes will be examined in the form of a 120-minute written exam or, if announced in advance, a 25-minute oral exam. The decision on the type of examination is made in good time and depends on the number of participants. Answering the questions and tasks may require the students to formulate their own answers. No aids are allowed.
By passing the examination, students demonstrate that they are able to explain the basic principles of property law, land policy, land law and land readjustment and to apply them in the context of a case. They further prove to be able to develop suitable concepts for engineering geodetic tasks around engineering structures and mechanical plants for given case constellations.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Mastery of all measurement and evaluation methods for solving local surveying tasks, as taught, for example, in the courses offered by the Department of Geodesy in the bachelor's degree program in Geodesy and Geoinformation.

Content:
In the lecture "Land Tenure and Land Radjustment" a detailed introduction and discussion in the areas of land policy, land law and land organization with the following topics takes place:
- Lines of development of the ownership of land
- property law
- Content and limits of ownership
- Basics of expropriation
- Definition of land law
- Land register and property law

These legal basic conditions are taken up by the contentwise emphasis of the lecture "basics of the engineer geodesy":
- Methods for project planning, setting out and acceptance of structures
- Quality specifications in the construction industry
- Exemplary applications, such as building construction, tunnels, bridge construction, dams, control of construction machines, machine and plant construction

Intended Learning Outcomes:
After participating in the module course, students are able to understand the comprehensive meaning of the concept of property. Furthermore, they are able to apply basic concepts from the field of land policy as well as practical examples in the context of land policy, land law and land readjustment. They are furthermore able to develop customized measurement concepts for engineering geodetic tasks in the planning and construction of buildings or industrial facilities.

Teaching and Learning Methods:
The teaching format is lectures and lectures with integrated exercises. Lectures and presentations are used as teaching methods. By explaining theoretical principles and practical examples, necessary background information and empirical values can thus be summarized and conveyed in context in the best possible way.
The teaching methods are geared towards the learning activities of researching material, studying literature and understanding, so that the learning content can be applied in later professional life or in practically oriented modules.

Media:
Powerpoint-Presentation, Handouts / Scripts

Reading List:
'- Ogundare, J.O. (2015): Precision Surveying: The Principles and Geomatics Practice, Wiley
- Schofiled, W. (2013): Engineering Surveying, 2nd Edition, Elsevier

Responsible for Module:
Prof. Dr. Christoph Holst

Courses (Type of course, Weekly hours per semester), Instructor:
Bodenrecht und Bodenordnung (Vorlesung, 2 SWS)
de Vries W [L], de Vries W

Basics of Engineering Geodesy (Vorlesung mit integrierten Übungen, 2 SWS)
Holst C, Weinhuber A
For further information in this module, please click campus.tum.de or here.

Module Description

ED110005: Mobile Laser Scanning | Mobiles Laserscanning

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
The intended learning outcomes will be assessed by a 25-minute oral exam (or a 120-minute written exam).
Here, at the end of the semester, the extent to which the students have an overall theoretical understanding of mobile laser scanning and its use in different geodetic scenarios is assessed and, in particular, the extent to which the students can apply and implement this knowledge to scenarios partially addressed in the exercises. A high emphasis is placed on knowledge, understanding, application, discussion and delineation. The corresponding fundamentals are taught in a combination of lecture and exercise.
No aids are allowed in the oral examination or the written exam. The decision whether a written exam or an oral exam is part of the examination performance will be announced to the students at least four weeks before the end of the lecture, depending on the number of students in the module.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge about geodetic measurement techniques and analysis methods are required. These are tought in the modules: - "Grundlagen der Vermessungskunde" (Bachelor GuG),
- "Sensorik und Methodik" (Bachelor GuG),
- "Satellitengestützte Positionierung und kinematische Geodäsie" (Bachelor GuG),
- "Geodetic Engineering and Consulting" (Master GuG).
Matlab knowledge is advantageous.

Content:
The following contents are planned:
- Introduction to mobile laser scanning

- Absolute sensors
- Inertial sensors
- Terrestrial laser scanning
- System calibration
- Estimation of the trajectory
- Calculation of the point cloud
- Quality analysis
- Applications and systems

Intended Learning Outcomes:
After completing the module, students will be able to design mobile multisensor systems using laser scanners, they will know the methods for creating georeferenced point clouds from mobile platforms using absolute and relative sensors, and they will be proficient in strategies for calibrating the multisensor system and analyzing the quality of the resulting point cloud.

Teaching and Learning Methods:
The module consists of a lecture and accompanying exercises. In the lecture, the scientific basics are taught in theory and on the basis of exemplary case studies. In the exercises accompanying the semester, concrete questions are worked on and answered in individual and group work, also outside of the presence time, and selected practice-oriented examples are solved.

Media:
'- Powerpoint-Präsentation
- Handouts

Reading List:
to be announced in the course

Responsible for Module:
Prof. Dr. Christoph Holst

Courses (Type of course, Weekly hours per semester), Instructor:
Mobiles Laserscanning (Vorlesung, 2 SWS)
Holst C, Xu Z

Mobiles Laserscanning - Übung (Übung, 2 SWS)
Xu Z
For further information in this module, please click campus.tum.de or here.

Module Description

ED110021: Geodetic Monitoring | Geodätisches Monitoring

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
The intended learning outcomes will be assessed by a 25-minute oral exam (or a 120-minute written exam).
Here, at the end of the semester, the extent to which the students have an overall theoretical understanding of geodetic monitoring measurements and their use in different geodetic scenarios is assessed and, in particular, the extent to which the students can apply and implement this knowledge to scenarios partially addressed in the exercises. A high emphasis is placed on knowledge, understanding, application, discussion and delineation. The corresponding fundamentals are taught in a combination of lecture and exercise.
No aids are allowed in the oral examination or the written exam. The decision whether a written exam or an oral exam constitutes the module examination depends on the number of students in the module, and will be announced to the students at least four weeks before the end of the lecture.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge about geodetic measurement techniques and analysis methods are required. These are tought in the modules:
- "Grundlagen der Vermessungskunde" (Bachelor GuG),
- "Sensorik und Methodik" (Bachelor GuG),
- "Satellitengestützte Positionierung und kinematische Geodäsie" (Bachelor GuG),
- "Geodetic Engineering and Consulting" (Master GuG).

Matlab knowledge is advantageous.

Content:
The following contents are addressed:

- Introduction into geodetic monitoring
- Measurement concept and instrumentation
- Geodetic Datum
- Setting up geodetic networks
- Deformation models
- Kalman filtering
- Time Series Analysis
- Uncertainty of complex measurement systems
- Monitoring based on point clouds
- Examples

Intended Learning Outcomes:
After completing the module, students are able to design, simulate, execute and evaluate engineering geodetic monitoring measurements on structures, machines or earth/rock masses and to analyze the results. To this end, they are able to use important modern measurement and evaluation methods.

Teaching and Learning Methods:
The module consists of a lecture and accompanying exercises. In the lecture, the scientific basics are taught in theory and on the basis of exemplary case studies. In the exercises accompanying the semester, concrete questions are worked on and answered in individual and group work, also outside of the presence time, and selected practice-oriented examples are solved.

Media:
'- Powerpoint-Presentation
- Handouts

Reading List:
'- Heunecke, O.; Kuhlmann, H.; Welsch, W.; Eichhorn, A.; Neuner, H. (2013): Handbuch Ingenieurgeodäsie, Auswertung geodätischer Überwachungsmessungen, 2. Auflage, Wichmann
- Ogundare, J.O. (2015): Precision Surveying: The Principles and Geomatics Practice, Wiley
- Schofiled, W. (2013): Engineering Surveying, 2nd Edition, Elsevier

Responsible for Module:
Prof. Dr. Christoph Holst

Courses (Type of course, Weekly hours per semester), Instructor:
Geodätisches Monitoring - Übung (Übung, 2 SWS)
Hosseini K, Yang Y

Geodätisches Monitoring (Vorlesung, 2 SWS)
Yang Y, Holst C, Hosseini K
For further information in this module, please click campus.tum.de or here.

Module Description

ED110022: Metrology and Quality | Messtechnik und Qualität

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
The form of examination is a scientific paper, with the aim of independently dealing with a challenging scientific or scientific-application-oriented problem using scientific methods. Students receive questions individually or in groups in the form of seminar topics, which they deal with through literature research, experiments (simulations or with real sensors) and the associated analysis. It should be demonstrated that a problem corresponding to the learning outcomes of the respective module can be completely processed in compliance with the guidelines for scientific work - from analysis to conception to implementation. The scientific elaboration is accompanied by a presentation in order to check the communicative competence of presenting scientific topics in front of an audience.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in geodetic measurement and analyses strategies are required. These are tought in the modules:
- "Grundlagen der Vermessungskunde" (Bachelor GuG),
- "Sensorik und Methodik" (Bachelor GuG),
- "Geodetic Engineering and Consulting" (Master GuG), - "Geodetic Monitoring" (Master GuG)
Matlab knowledge is advantageous.

Content:
Some sample seminar topics are: - Quality of terrestrial laser scanners, mobile laser scanners, GNSS, tacheometry, inclination measurements, hose level, EDM
- Methods for testing, calibration and quality analysis of the sensors

- Methods for the description of measurement uncertainty, e.g. B28covariance matrix, procedure according to the Guide to the Expression of Uncertainty in measurements, Monte Carlo Simulations

Intended Learning Outcomes:
After completing the module, students will be able to examine and assess geodetic measuring instruments and sensors with regard to their quality. They are familiar with the measurement technology of the instruments covered, with methods for describing measurement uncertainty and with contemporary testing and calibration methods. They are able to approach these topics by means of literature, own measurement and method implementations as well as on the basis of exemplary measurements or simulations. These learning outcomes are achieved by issuing appropriate seminar topics to be worked on individually or in groups. Regular meetings with mutual presentations increase the methodological competence.

Teaching and Learning Methods:
Presentations, planning, execution and analysis of simulations or measurements, literature research

Media:
'- Powerpoint presentations - Handouts
- Whiteboard / flipchart

Reading List:
'- Ogundare, J.O. (2015): Precision Surveying: The Principles and Geomatics Practice, Wiley
- Schofiled, W. (2013): Engineering Surveying, 2nd Edition, Elsevier

Responsible for Module:
Prof. Dr. Christoph Holst

Courses (Type of course, Weekly hours per semester), Instructor:
Metrology and Quality (Seminar, 4 SWS)
Holst C
For further information in this module, please click campus.tum.de or here.

Module Description

ED110029: Spatial Data Management and System Architectures - Advanced Methods | Geodatenverwaltung und Systemarchitekturen - Weiterführende Methoden

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
The module is completed by means of a 120-minute written examination. In this exam the students have to prove that they understand the principles of different types of database systems as well as spatial indexing, that they are able to apply spatial functions for querying geodata, design patterns for managing spatial data as well as database scripting and triggers for managing databases. Furthermore, the students have to prove that they understand the technical basics of Geo Web Services as well as virtualization concepts and cloud and serverless computing for geodata management, that they are able to formulate queries to Geo Web Services and interpret answers correctly and that they are able to evaluate the suitability of different types of Geo Web Services for selected use cases.
For this purpose, problems must be analyzed in a limited amount of time and, based on the learning outcomes acquired during the module, solutions must be found and also implemented. The answers require partly own formulations, partly ticking of given multiple answers, with the emphasis on own formulations.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fundamentals of geospatial data management and system architectures as taught in the module "Geospatial Data Management and Visualization".

Content:
In this course, students will learn the following advanced concepts about database systems: spatial indexing, spatial functions, design patterns for geodatabase schemas, database scripting and triggers, NoSQL databases. Furthermore, the following knowledge in the area of system

architectures will be taught: Principle of Geo Web Service approach, International standards for Geo Web Service interfaces and APIs, platforms, virtualization concepts, cloud and serverless computing for geospatial data management.

Intended Learning Outcomes:
Upon successful completion of the module, students will be able to:
- understand the different concepts for spatial indexing,
- distinguish different types of spatial database systems (relational, NoSQL),
- apply selected spatial functions based on database systems,
- apply design patterns for database schemas for spatial data management, and
- apply database scripting and triggers in the context of spatial data management.

In addition, students will be able to:
- understand technical principles for Geo Web Services to make geospatial data and functions available on the Internet and to establish interoperability between geospatial information systems and between geospatial information systems and general IT systems,
- understand virtualization concepts, cloud and serverless computing for geospatial data management,
- perform queries to different types of Geo Web Services,
- interpret responses from different types of Geo Web Services,
- analyze international standards for Geo Web Service interfaces and API,
- evaluate the suitability of different types of Geo Web Services for selected use cases.

Teaching and Learning Methods:
The course consists of a lecture with accompanying exercise. The lecture serves the purpose of providing the theoretical foundations. In the exercise the students are deepening the theoretical foundations by applying common software tools.

Media:
Moodle e-learning, presentations, scripts, specialized software

Reading List:
Will be announced at the beginning of the course

Responsible for Module:
Thomas H. Kolbe

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

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

Module Description

ED110046: Internet of Things in the Built Environment | Internet der Dinge in der gebauten Umwelt

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
The expected learning outcomes will be assessed in the form of a project work, which will be carried out in small groups. The assessment takes place in three oral presentations (a kick-off, an intermediate and a final presentation), a written discussion of original scientific literature (paper review), as well as a final written report on the project work. The presentations are suitable for reviewing the skills acquired during the project work. The presentations, followed by a discussion, are intended to test communicative competence in presenting one's own development results to an audience. The paper review aims at verifying that the students are able to critically deal with scientific publications in the field of Internet of Things (IoT).
The project report is intended to test the extent to which students are able to summarize results in writing or to document their own research and development results.
The project will be completed outside of in-class hours. Students must prove that they are able to independently develop a project from the topic area of the Internet of Things (IoT) and geosensor networks to a finished IoT application.
The weighting of the final grade is as follows: Presentations (kick-off, interim and final presentation) 30%, paper review 20%, written report on the project work (including assessment of the achievement of the project objectives) 50%.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic programming knowledge is expected, as taught in the first and second semester in the courses "Computer Science I" and "Computer Science II" of the bachelor degree program Geodesy and Geoinformation or Environmental Engineering. Knowledge in programming with C++, JavaScript, HTML, CSS, Python, SQL, etc., as well as the usage of web services are advantageous, but not mandatory.

Content:
The focus of the module is to provide skills for analysis, concept development and implementation of IoT projects where data is collected using sensors, transmitted to the Internet using various network technologies and managed, visualized and analyzed using open standards for geosensor networks.
The course includes an introduction to IoT hardware. Microcontrollers, a range of sensors, actuators and indicators, and the most common protocols for communication between controllers and peripherals will be introduced. Furthermore, communication hardware and protocols of microcontrollers are discussed. The focus here is on the low power wide area radio network technology LoRa and the LoRaWAN protocol. For sensor data management, the basics of interoperable open standards for geosensor networks (including OGC Sensor Web Enablement and SensorThings API) will be taught and standards-compliant services and protocols will be used. In addition, methods and tools for visualization and analysis of time series data will be presented and used during the course.

Intended Learning Outcomes:
After successful completion of the module, students are able to ...
- explain basic methods and technologies of the Internet of Things, geosensor networks and their applications,
- to evaluate scientific publications in the field of Internet of Things (IoT)
- develop, prototypically implement and document selected IoT projects and problems related to geosensor networks,
- to present the self-developed results in scientific form in front of an audience and to argue about them.

Teaching and Learning Methods:
In the first weeks of the course, lectures and scientific publications are used to teach the theoretical basics of the Internet of Things (hardware, protocols) and geosensor networks. In parallel, the students receive the project hardware and are introduced to the installation and programming of the components in the form of practical exercises with the supervisors.
Afterwards, the students independently develop a concept for the implementation of their own projects in small groups. The supervision of the project work takes place in weekly tutoring sessions with the tutors and lecturers.

Media:
Moodle e-learning, presentations, scripts, specific software

Reading List:
Will be announced at the beginning of the course

Responsible for Module:
Kolbe, Thomas; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Geo Sensor Networks and the Internet of Things (Vorlesung mit integrierten Übungen, 4 SWS)
Kolbe T (Gitahi J, Schwab B), Donaubauer A, Knezevic M
For further information in this module, please click campus.tum.de or here.

Module Description

ED110062: Remote Sensing - Seminar | Fernerkundung - Seminar

Version of module description: Gültig ab winterterm 2022/23

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 learning outcomes will be assessed in the context of a 20-minute presentation followed by a discussion. It is to be tested to what extent the students are able to explain technical, task-oriented solutions in the area of remote sensing methods in a theoretically and methodologically sound discourse in front of an expert audience.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of photogrammetry, mathematics and physics.
Successful participation in the module Introduction to Photogrammetry, Remote Sensing and Digital Image Processing (BGU48036).

Content:
The seminar provides a deep insight into specific and selected topics of current remote sensing research, e.g.:
- Along-track and Across-track interferometry
- Differential SAR interferometry
- Persistent Scatterer Interferometry
- Remote sensing of the atmosphere
- Hyperspectral Remote Sensing

Intended Learning Outcomes:
After successful completion of the module, students will be able to:
- assess the applicability of specific remote sensing methods for practical problems
- to independently analyze tasks from the research field of remote sensing
- to develop methodological basics for a selected research topic

- to evaluate alternative approaches in practice and to develop own solutions
- present the results in a report and/or lecture.

Teaching and Learning Methods:
In the seminar, the fundamentals taught in the lecture are applied through independent work on a current research topic as well as through presentation and discussion of the results obtained.

Media:
Slides, literature

Reading List:
selected literature (such as scientific papers) will be provided for each topic individually

Responsible for Module:
Zhu, Xiaoxiang; Prof. Dr.-Ing. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Seminar Fernerkundung (Seminar, 2 SWS)
Zhu X [L], Zhu X
For further information in this module, please click campus.tum.de or here.

Module Description

ED110063: Practical Course in Laser Scanning | Praktikum Laserscanning

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 45	**Contact Hours:** 45

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

Description of Examination Method:
Examination consists of a marked final report (length of 8 to 10 pages) and a marked presentation (15 minutes length) in the weight 3:1 (75% report, 25% presentation). In it, students show their structural project planning, researched background information, procedure, calculations and results. By this, the report reflects all project steps and allows a clear assessment of each step's quality. Additionally, the students will need to give a presentation about the work.
When working in groups, a corporate report is possible, as well as individual reports on the students' choice. In the latter case, individual efforts have to be indicated.
Unsufficient projects may not be repeatedly examinated; in this case another project topic has to be chosen and worked out.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in engineering surveying and – depending on the chosen topic – in further geodetic basic fields are required. These can, e.g., be obtained in the bachelor modules of "geodesy and geoinformatics".

Content:
'- Measuring and processing of point clouds, measured using static or mobile laser scanning
- Solving engineering tasks, as 3D capturing of areoplanes, buildings, indstrial facilities and correspondnig geometric analysis of the data
- Measurement planning and use of laser scanners, either static or mobile
- Evaluation of data using geodetic software
- Creation of well-designed reports

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage, Laserscanner auf Problemstellungen anzuwenden, die Messprodukte zu analysieren und die Ergebnisse zu bewerten. Beispielhaft sind sie in der Lage, ein Bauwerk mit Laserscanning effizient zu vermessen, die resultierende Punktwolke hinsichtlich versch. Registrierverfahren zu analysieren und das fertige Resultat hinsichtlich der erreichten Genauigkeit zu bewerten.

Teaching and Learning Methods:
The modul consists of a supervised project work, which is an individual or group work (depending on the topic).
Students perform research, calculations, practical measurements and report creation mostly independently and are supervised by their tutors on demand, who also demonstrate possibilities for improvement.

Media:

Reading List:
is provided depending on topic

Responsible for Module:
Holst, Christoph; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Praktikum Laserscanning (Praktikum, 3 SWS)
Holst C, Xu Z
For further information in this module, please click campus.tum.de or here.

Module Description

ED110087: Data Science in Earth Observation | Datenwissenschaft in der Erdbeobachtung

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:** 75	**Contact Hours:** 75

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

Description of Examination Method:
The expected learning outcomes are verified by a project work.

The topic of the project work will be selected from a list of practical data science problems in Earth observation, such as land use land cover classification, building footprint segmentation, and biomass estimation etc. The students will work in teams of 2-3. Each team needs to design, implement, and experiment the machine learning model for the seleted task. A final report about 10 pages in length describing the research outcome needs to be submitted.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Prerequisites are basic knowledge of Linear Alegbra, estimation theory. Mathematics 1 & 2 from the BSc programm Geodesy & Geoinformation are recommended.

Knowledge in python or matlab, or a similar programming language is necessary for the project work.

Content:
Deepening of knowledge in Data Science in Earth observation:
- Introduction to the mathematical basis of machine learning methods, including support vector machine, random forest, deep neural networks, convolutional neural networks, and recurrent neural networks;
- explain typical tasks in Earth observation such as image classification, image segmentation, and regression, and explain the appropriate machine learning methods;

- explain open issues in data science in Earth observation, such as domain shift across sensors and geographical regions, category gap, generalizability and transferrability, sparse and errornous labels;
- explain typical machine learning workflow of an Earth observation problem, including supervised and unsupervised machine learning;
- explain the difference between physical model and data-driven model, and their uncertainty quantification in Earth observation problems;
- AI4EO Hackatons to strengthen the theoretical knowledge
- Development of machine learning model for a specific task in Earth observation in a project work

Intended Learning Outcomes:
After successful completion of the module students are able to
- grasp the mathematical basics of typical machine learning methods such as support vector machines and random forest, and deep neural network models;
- understand different types of machine learning methods, and their typical applications in Earth observation;
- understand the difference between a well defined physical model, and a machine learning model and understand their advantages and disadvantages;
- know the methods to quantify uncertainty in deep neural network
- understand a typical machine learning workflow for Earth observation problems, such as reference data labeling, neural network architecture design, model training, fine tuning, validation, etc;
- select and implement appropriate models for specific Earth observation problems, design fair experiments to compare different models, and validate the results accuracy;
- write concise and objective scientific report of a reasearch outcome.

Teaching and Learning Methods:
The module consists of a lecture, a Hackathon and project work.

The contents of the lectures are taught in lecture and through presentations. Interaction with the students is encouraged through the use of questioning-developing methods.

The Hackathons will help the students to get familiar with typical problem solving in Earth observation, and prepare for the project work. For the Hackathon mainly Python is used.

In the projects, practice examples on selected topics are dealt with. Here, the focus is on working through problems and finding solutions, partly in partner and group work, in order to deepen the theoretical foundations taught in the lecture by means of practical tasks and thus to impart the skills of independent analysis and evaluation of machine learning models and their results.

Media:
- Blackboard
- Presentation in electronic form
- Computer script and Earth observation data

Reading List:
Gustau Camps-Valls, Devis Tuia, Xiao Xiang Zhu, Markus Reichstein (Editors) (2021). Deep learning for the Earth Sciences: A comprehensive approach to remote sensing, climate science and geosciences, Wiley & Sons, 2021.

Responsible for Module:
Zhu, Xiaoxiang; Prof. Dr.-Ing. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Data Science in Earth Observation (Vorlesung mit integrierten Übungen, 5 SWS)
Zhu X [L], Zhu X
For further information in this module, please click campus.tum.de or here.

Module Description

ED110142: Geodetic as-built Surveys | Geodetic as-built Surveys

Version of module description: Gültig ab winterterm 2023/24

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

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

Description of Examination Method:
Module requirements are examined by a 60 minutes written exam without auxiliary material or a 20 min oral exam. In this, comprehension questions and calculation tasks are used to check whether the students can explain and apply the functioning of geodetic measuring instruments and fundamental aspects of the associated evaluation procedures.
The decision on whether the exam will be written or oral depends on the students' number and will be announced at least four weeks before the end of the lectures.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Coordinate systems
Instruments
Electronic total stations
Trigonometric measurements
Levelling and trigonometric height determination
Terrestrial laser scanning – the principles
Terrestrial laser scanning – the usage
Global Navigation Satellite Systems (GNSS)
Transformation of global coordinates into official coordinates
Distance reductions
Surveying and BIM

Intended Learning Outcomes:
After participating in the module, students will be able to understand and use the functionality of geodetic measuring instruments such as total stations, leveling, GNSS and laser scanning. In addition, basic aspects of the associated evaluation methods for each measuring instrument can be assigned, applied and further developed.

Teaching and Learning Methods:
Weekly lectures in the lecture hall to explain the theoretical content, as well as some practice sessions at the Max-Kneißel Institute in Eichenau or outside the TUM main campus. The experimental exercises reinforce the theoretical foundations of the lecture and provide important input for the exam.

Media:
Powerpoint presentation; teaching videos; literature review;

Reading List:
- Ogundare, J.O. (2015): Precision Surveying: The Principles and Geomatics Practice, Wiley
- Schofield, W. (2013): Engineering Surveying, 2nd Edition, Elsevier

Responsible for Module:
Holst, Christoph; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Exercises Geodetic as-built surveys (Übung, 3 SWS)
Holst C, Hosseini K

Geodetic as-built surveys (Vorlesung, 2 SWS)
Holst C, Hosseini K
For further information in this module, please click campus.tum.de or here.

Module Description

ED120067: Foundations of Integrated Product Design | Foundations of Integrated Product Design

Version of module description: Gültig ab summerterm 2024

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:
Die Modulprüfung wird in Form einer Projektarbeit erbracht, diese ist in Zwischenkritiken und einer Abschlusspräsentation (live oder als max. 5-minütiges Video) zu präsentieren. Bewertet wird die Projektarbeit als Gesamtes; sie besteht aus den folgenden einzureichenden Elementen: (1) Recherche und Analyse, (2) Ideen- und Formfindung in Form von Skizzen, Moodboard und Vormodellen, sowie (3) Ausarbeitung eines Konzepts als Technische Zeichnung, Rendering und finales Modell. Der Schwerpunkt der Prüfungsleistung liegt auf Punkt (3), der mit 40% in die Bewertung eingeht, die Punkte (1) und (2) werden mit jeweils 20% gewichtet.

Zusätzlich zu den o.g. einzureichenden Elementen sind diese auch in einer schriftlichen Dokumentation in Form von visuellen Darstellungen, Fotos und beschreibenden Texten zusammenzufassen und kritisch zu reflektieren (Broschüre, mind. 15 Seiten). Diese Dokumentation geht, zusammen mit der Abschlusspräsentation, zu 20% in die Gesamtbewertung ein.

Anhand der Abgaben und Präsentation wird überprüft, inwiefern die Studierenden in der Lage sind, einen niederkomplexen Entwurf selbstständig zu entwickeln und diesen professionell zu visualisieren und zu kommunizieren.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Keine

Content:
Das Seminar „Foundations of Integrated Product Design“ vermittelt einen Überblick über den typischen Entwurfsprozess im Produktdesign. Grundlegende Konzepte des Produktdesigns werden thematisiert, beispielsweise historische Entwicklungen und aktuelle Designpositionen, Fertigungstechniken, Kostenkalkulation, Vermarktungsstrategien, sowie typische und zukünftige Arbeitsfelder.
Exemplarische Aufgabenstellungen beschäftigen sich mit
• der Gestaltung von niederkomplexen Produkten, z.B. Wohnaccessoires (Table-Top), Kleinmöbel oder Leuchten
• der Optimierung des Entwurfs für die Produktion als Kleinserie
• der Entwicklung eines Geschäftsmodells und einer Marketingstrategie für den eignen Entwurf
• Designmethoden und User Research
• Formfindung, Gestaltprinzipien und Semiotik
• Modellbautechniken (analog und digital)

Intended Learning Outcomes:
Nach der erfolgreichen Teilnahme am Seminar „Foundations of Integrated Product Design“ sind die Studierenden in der Lage:
• ein niederkomplexes Produkt eigenständig zu entwerfen und innerhalb eines vorgegebenen Zeitrahmens als 1:1 Prototyp zu realisieren
• ihren Entwurf anhand von Skizzen, Zeichnungen und Modellen professionell zu visualisieren
• den Aufwand und Wert ihrer Arbeit einzuschätzen
• den gesamten Designprozess in zukünftigen Projekten selbstständig anzuwenden
• die Rolle des Produktdesigns im Zusammenspiel mit anderen Disziplinen einzuordnen

Teaching and Learning Methods:
Grundlegende Kenntnisse werden in Kurzvorlesungen vermittelt, und im Anschluss in praktischen Entwurfsübungen selbstständig angewendet.
In geeigneten Fällen wird das Entwerfen als Teamarbeit (2-3 Personen) organisiert; die Teams können auch interdisziplinär zusammengesetzt sein. Regelmäßige Inputs, Literaturrecherche im Selbststudium, Entwurfsbesprechungen sowie mehrere Zwischenpräsentationen im Lauf des Semesters fördern den kritischen Diskurs und die Reflexion der eigenen Arbeit.

Media:
Themenspezifisch

Reading List:
Themenspezifisch

Responsible for Module:
Prof. Katja Thoring

Courses (Type of course, Weekly hours per semester), Instructor:
Foundations of Integrated Product Design (Seminar, 4 SWS)

Thoring K [L], Thoring K, Dreyer S
For further information in this module, please click campus.tum.de or here.

Module Description

ED130013: Prognostics and Health Management | Prognostics and Health Management [PHM]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 45	**Contact Hours:** 45

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

Description of Examination Method:
The module assessment takes place as oral examination of 30min duration. The student will be presented with one problem that is oriented at the contents of the course as well as the homework and
exercises throughout the semester. The students will be given 15min to study the problem and outline
their solution. Subsequently they will present their solution and answer follow-up questions. The students have to be able to describe and reflect important theories. Solutions will be discussed and examined during iterative rounds of questions. The oral examination enables the examiners to be responsive to the individual student and to evaluate the student’s competences realistically.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Risk Analysis/Stochastic Finite Element Methods
The module will assume a basic knowledge of probability concepts such as random variables and their description (e.g., through completion of the MSc module “Risk Analysis” or “Stochastic Finite Element Methods”). Basic knowledge of Matlab (or Python) is required for the exercises.

Content:
The module introduces methods for predicting the degradation behavior of engineering systems and their remaining useful life to determine appropriate maintenance actions. Two different categories of methods are discussed: physics- and data-driven methods. The performance of the methods is demonstrated with the help of practical examples from different engineering fields.
Contents:
1. General introduction

2. Prediction of degradation behavior
2(a). Least squares method
2(b). Physics- vs. data-driven approaches
2(c). Prediction of remaining useful life
2(d). Prediction uncertainty
3. Basics of Bayesian analysis
3(a). Bayes' theorem
3(b). Recursive Bayesian updating
3(c). Generating samples from the posterior distribution
4. Physics-based prognostics
4(a). Nonlinear least squares
4(b). Markov chain Monte Carlo
4(c). Particle filter
5. Data-driven prognostics
5(a). Gaussian process regression
5(b). Neural networks

Intended Learning Outcomes:
This module enables the students to understand and implement methods for predicting the degradation behavior of engineering systems through combining data and engineering models. In the end of the semester the students will be able to:
- Estimate the remaining useful life of engineering systems through combining models with data
- Apply nonlinear least squares to estimate parameters of engineering models
- Apply the Bayesian approach to parameter estimation using MCMC methods and particle filters
- Apply machine learning methods for data-driven predictions
- Estimate the uncertainty of machine learning-based degradation predictions
- Assess the advantages and disadvantages of physics- and data-driven approaches
- Implement prognostics methods in the Matlab computer environment

Teaching and Learning Methods:
The module consists of weekly lectures with integrated exercises. Lectures will be given partly on the black/whiteboard and partly by presentations on slides. The whiteboard allows to derive theoretical concepts and mathematical formulations at a pace that is conducive to a deeper understanding. The presentations on slides facilitates graphical illustration of the new concepts and enables to make complex content more comprehensible.
Tutorial exercises will be given and their solutions will be posted in moodle and a selection thereof will be solved in class. Solution of the exercises will require the use of the Matlab software. Exercises facilitate understanding of the taught methods and their applicability to different problems.

Media:
- Lectures with blackboard supported by slides
- Exercise sheets
- Matlab code examples

Reading List:
The module is based on Chapters 1-5 of the following book:
Kim, N. H., An, D., & Choi, J. H. (2017). Prognostics and health management of engineering systems. Switzerland: Springer International Publishing.
For further reading, the following are recommended:
An, D., Choi, J. H., & Kim, N. H. (2013). Prognostics 101: A tutorial for particle filter-based prognostics algorithm using Matlab. Reliability Engineering & System Safety, 115, 161-169.
Meng, H., & Li, Y. F. (2019). A review on prognostics and health management (PHM) methods of lithium-ion batteries. Renewable and Sustainable Energy Reviews, 116, 109405.

Responsible for Module:
Iason Papaioannou

Courses (Type of course, Weekly hours per semester), Instructor:
Prognostics and health management (Vorlesung mit integrierten Übungen, 3 SWS)
Papaioannou I, Koutas D
For further information in this module, please click campus.tum.de or here.

Module Description

ED130016: Computational Design and Fabrication | Computational Design and Fabrication [CDF]

Version of module description: Gültig ab summerterm 2022

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 exam consists of a series of assignments and a design project. The results will be presented in form of a final presentation. The assignments are programming exercises which cover various topics of computational design. The design project is carried out by the students using a chain a computational tools for structural design, shape optimization and digital fabrication. Moreover, the project includes the construction of physical prototypes within a dedicated fabrication workshop. Through the design project, the students prove that they learned the theoretical content and can apply it to a practical task. The evaluation of the design project is based on the individual steps of the process as well as the resulting design.
The design project will be presented in the final presentation (around 30 minutes). Through the final presentation, the students show that they are able to present their work in front of a general audience, to analyze various aspects of their design, and to propose potential improvements.
The module grade consists of the assignments (25%), the design project and fabrication workshop (50%) and the associated final presentation (25%).

Repeat Examination:

(Recommended) Prerequisites:
Basic knowledge of programming (e.g. in Python) and/or Rhino Grasshopper (software) is an advantage.

Content:
The course bridges fundamental principles of geometric computing and design and leverage these insights to develop new algorithms and tools for 3D shape generation, simulation, structural design, and digital fabrication in design and engineering. Students are taught innovative computational design solutions for advanced fabrication and construction at various scales at

the interface of different scientific disciplines, such as mathematics, computer science, structural engineering and architecture.
The course covers the following topics:
• Introduction to the application of Computational Geometry and Computational Mechanics in Structural Design
• Introduction to the general notions of Fabrication-Aware Design
• Introduction to the processing of geometry, data structures, robot programming, and interfaces
• Introduction to selected computational design tools and fabrication technology
• Domain-specific case studies with a practical design and fabrication task

Intended Learning Outcomes:
After attending the course, students will be able to:
• learn and apply the basic principles of parametric and algorithmic design,
• implement basic versions of selected algorithms related to architectural geometry, structural design and digital fabrication,
• use common CAD tools as interfaces to self-implemented solutions,
• gain basic knowledge through practical exercises in computational design,
• gain hands-on knowledge in digital fabrication,
• understand the scope and relevance of computational methods for architectural research and practice.

Teaching and Learning Methods:
The module consists of a series of lectures, computer exercises, fabrication experiments and a specific design project. In the course, essential theoretical and practical foundations of computer-aided integrated design are conveyed. Specific attention is given to structural form-finding, shape optimization and digital fabrication technologies. These foundations are practically deepened by assignments.

The course will follow this structure:
• At the beginning, the theoretical aspects of Computational Design and Digital Fabrication are taught in frontal lectures.
• The theoretical aspects are put into practice by students in programming assignments
• A chain of computational design tools is presented and demonstrated by means of examples.
• This software is used by the students to carry out the design project.
• Students digitally fabricate physical prototypes in various scales in order to validate their design proposals
• At the end, all design projects and prototypes are presented and discussed

Media:
Presentation supported by media (PowerPoint, videos, etc.), notes at the blackboard, teaching software and tools for digital fabrication.

Reading List:
References will be provided at the beginning of the semester

Responsible for Module:
Dr. Majid Hojjat (hojjat@tum.de)

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

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

Module Description

ED150001: Modeling Urban Development | Modellierung von Stadtentwicklung [Modeling Urban Development]

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:
Written exam (90 minutes)

Repeat Examination:

(Recommended) Prerequisites:
None

Content:
This module discusses various types of models that are used to predict urban development with a mathematical model, including
- Agent-based simulation of land use
- Input-Output models of urban development
- Cellular Automata models of urban growth
- System Dynamics models
Students will learn about underlying theory, data requirements, use cases and limitations of such models.

Intended Learning Outcomes:
After successfully completing the module, students are able to
- Understand the principles of modeling urban development
- Compile and defend reasons to apply models to predict urban development
- Apply models for urban development to selected use cases
- Compile and describe data needs for models of urban development
- Understand and describe differences between agent-based models, input-output models, cellular automata models and system dynamics models.

- Describe limitations of modeling urban development

Teaching and Learning Methods:
The module consists of lectures and seminars. During the lectures, the theoretical background is presented by presentations and PowerPoint slides. During the seminars, students will engage in group interactions to gain practical experience in modeling urban development.

Media:
PowerPoint presentation, open discussions, small group assignments

Reading List:
- Acheampong, R. A. & Silva, E. (2015) Land use–transport interaction modeling: A review of the literature and future research directions. Journal of Transport and Land Use, 8(3), 11–38. doi:10.5198/jtlu.2015.806
- Clarke, G.P. (1996) Microsimulation for Urban and Regional Policy Analysis. European research in regional science, vol. 6. Pion: London
- Hunt, J. D., Kriger, D. S. & Miller, E. J. (2005) Current operational urban land-use-transport modelling frameworks: A review. Transport Reviews, 25(3), 329–376. https://doi.org/10.1080/0144164052000336470
- Simmonds, D., Waddell, P. & Wegener, M. (2011) Equilibrium vs. dynamics in urban modelling. Environment and Planning B: Urban Analytics and City Science, 40(6), 1051–1070. https://doi.org/10.1068/b38208
- Vorel, J. (2015) Urban Simulation Modeling. An introduction and Experimental Applications in the Czech Republic. Czech Technical University: Prague.
- Wegener, M. (2014) Land-use transport interaction models. In M. Fischer & P. Nijkamp (Eds.), Handbook of regional science (pp. 741–758). Berlin, Heidelberg: Springer.

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

Courses (Type of course, Weekly hours per semester), Instructor:
Modellierung der Stadtentwicklung (Vorlesung) (Vorlesung, 2 SWS)
Moeckel R [L], Moeckel R

Modellierung der Stadtentwicklung (Übung) (Übung, 2 SWS)
Moeckel R [L], Moeckel R
For further information in this module, please click campus.tum.de or here.

Module Description

IN2157: Fundamental Algorithms | Grundlegende Algorithmen (CSE)

Version of module description: Gültig ab winterterm 2022/23

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

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

Description of Examination Method:
The examination consists of a written exam of 90 minutes. In the exam, students prove in the given exercises that they have command of the fundamentals of the algorithms and data structures discussed in the module. They are able to apply their knowledge and solve respective algorithmic problems within limited time. Exercise may include:
determining the complexity of sorting, arithmetic or graph algorithms using the discussed complexity models;
determining non-functional properties (correctness, level of parallelism, etc.) of these algorithms;
discussion of the appropriateness of certain algorithms to meet additional requirements.
Answers require own formulations and computations.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
IN0001 Einführung in die Informatik 1

Content:
The module provides an overview of fundamental sequential and parallel algorithms, as well as an introduction to the analysis of algorithms. Typical topics include:
Fundamentals: models of computation, complexity measures, loop invariants and induction techniques to prove the correctness of algorithms
Sorting: Bubble-Sort, Merge-Sort, Quick-Sort, median algorithms, lower bounds for sorting, sorting in parallel
Searching: linear and binary search, search trees (AVL Trees), hashing, etc.
Arithmetic problems: parallel prefix computation, parallel matrix and vector operations
Graph algorithms: graph traversal, transitive closure, shortest paths, minimum spanning trees

These algorithms are used as examples to present and exercise the application of models of computation, complexity measures and techniques for analysis and proofs.

Intended Learning Outcomes:
Participants understand fundamental algorithms (incl. simple parallel algorithms) and are able to apply them. They can analyze the complexity and the parallelism properties of moderately complex algorithms. For algorithms that are discussed in the module, they are able to prove such properties using the discussed techniques. Participants are also able to assess the appropriateness of these algorithms for specific problems.

Teaching and Learning Methods:
This module comprises lectures and accompanying tutorials. The contents of the lectures will be taught by talks and presentations. Students will be encouraged to study literature and to get involved with the topic in depth. In the tutorials, concrete problems will be solved (partially in teamwork) and selected examples will be discussed.

Media:
Slides, blackboard

Reading List:
- Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, Clifford Stein. Introduction to Algorithms. 2. Auflage, MIT Press, Cambridge, MA, 2001.
- Jon Kleinberg, Eva Tardos. Algorithm Design. Pearson Education, Boston, MA, 2005.
- Russell L. Shackelford , Introduction to Computing and Algorithms. Addison Wesley, 1997.
- Robert Sedgewick, Kevin Wayne. Algorithms. 4th Edition, Pearson Education, 2011.

Responsible for Module:
Albers, Susanne; Prof. Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Fundamental Algorithms (CSE) (IN2157) (Vorlesung, 2 SWS)
Seidl H [L], Azeem Muqsit -, Grover K, Seidl H
For further information in this module, please click campus.tum.de or here.

Module Description

LRG1500: Principles of Spatial Data Mining and Machine Learning | Prinzipien räumlichen Data Minings und maschinellen Lernens [SDML]

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 45	**Contact Hours:** 45

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

Description of Examination Method:
The successful completion of this module is checked in a written examination (60 minutes) in which the students have to prove that they are able to solve problems from the domain of spatial data mining in limited time. The answers involve free formulations as well as multiple-choice questions. By answering questions, students show their knowledge of techniques such as linear models, spatial correlation, cross-validation, decision trees, spatio-temporal clustering algorithms and more. In open questions, they demonstrate the ability to do method selection, model evaluation, or model design in concrete scenarios.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The module Big Geospatial Data is helpful.

Content:
In this lecture, the students learn how the field of data mining has originated from predictive modeling, the core techniques of unsupervised (clustering) and supervised data mining are introduced (rules, trees, naive bayes, multilayer perceptrons, etc.) and applied in both a classification and a regression setting. Special attention is given to spatial data including relevant algorithms, treatment of missing values, treatment of uncertainty, spatial autocorrelation, model selection, model fusion, and data cleaning.

Intended Learning Outcomes:
By completing this module, students will be enabled to extract knowledge from spatial and spatio-temporal datasets following techniques from data mining and machine learning including linear models, kNN models, regression models, classification models, decision trees, NaiveBayes,

Support Vector Machines and more. These methods are applied to spatial datasets including point clouds, trajectory datasets, event databases, spatial networks, text, and multimedia data. Students get an overview of methods and techniques to explore big geospatial datasets using data mining techniques.

Teaching and Learning Methods:
Lecture and Tutorial with Concrete Examples

Media:
Presentation, handout, examples, and screencasts.

Reading List:
Hints on current literature for this quickly evolving field are given in the lecture.

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

Courses (Type of course, Weekly hours per semester), Instructor:
Prinzipien räumlichen Data Minings und maschinellen Lernens - Übung (Übung, 1 SWS)
Werner M [L], Li H

Prinzipien räumlichen Data Minings und maschinellen Lernens (Vorlesung, 2 SWS)
Werner M [L], Li H
For further information in this module, please click campus.tum.de or here.

Module Description

LRG2000: Big Geospatial Data | Big Geospatial Data [BGD]

Version of module description: Gültig ab summerterm 2020

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 45	**Contact Hours:** 45

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

Description of Examination Method:
The successful completion of this module is checked in a written examination (60 minutes) in which the students have to prove that they are able to solve problems from the domain of big geospatial data management in limited time. The answers involve free formulations as well as multiple-choice questions.

Note in view of the limitations on university operations as a result of the CoViD19 pandemic: If the basic conditions (hygiene, physical distance rules, etc.) for a classroom-based examination cannot be met, the planned form of examination can be changed to a written or oral online examination in accordance with §13a APSO. The decision about this change will be announced as soon as possible, but at least 14 days before the date of the examination by the examiner after consultation with the board of examiners of the respective study program.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Foundations of GIS or Geoinformatics are needed, experience in programming in more than one programming language is very helpful.

Content:
In this lecture, the students learn how current systems for dealing with big data are organized, implemented, programmed, deployed, and used. We focus on fundamental mechanisms including data distribution, data replication, distributed programming models, MPI and MapReduce. In addition, we discuss specifics of spatial data including different ways of distirbuting this data (R-trees, grids, space-filling curves) and when and how to use them.

Intended Learning Outcomes:
By completing this module, students will be enabled to work with big datasets of spatial nature both in scientific environments using cluster computing architectures based on MPI as well as in scalable computing models such as cloud computing more tailored to business adoption.

Teaching and Learning Methods:
Lecture and Tutorial with concrete examples

Media:
Presentation, handout, examples, and screencasts.

Reading List:
Hints on current literature for this quickly evolving field is given in the lecture.

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

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

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

Elective Modules TUM | Wahlmodule aus dem TUM-Katalog

Module Description

AR17110: Applied Presentation Technology | Tutorium Angewandte Darstellungstechnik

Version of module description: Gültig ab summerterm 2018

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

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

Description of Examination Method:
Portfolio of work and timely hand-in of assignments. Usually this takes the form of a portfolio of drawings.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Prior successful participation in the Modules AR20072: Principles of Presentation and AR20073: Principles of Design, i.e. good hand drawing skills, knowledge of perspective drawing and presentation and an interest in the visual communication of spatial qualities.

Content:
The applied presentation techniques module is concerned with the visual communication in space. Using the vehicle of a concept for an installation in an interior or an intervention in the urban realm, students explore design concepts for the visual appearance of a space. Students examine design guidelines for communicating spatial architectonic concepts using visual means and develop designs for the visual appearance of a space including color scheme and material concepts.

Intended Learning Outcomes:
At the end of the module, students will have gained experience of visual design in space and the means and methods of its application. They will also have developed a concept of their own and put it into practice.

Teaching and Learning Methods:
In a weekly seminar, we introduce the principles of applied presentation techniques and discuss with the students their respective design concepts and their ongoing development.

Media:
Depending on the respective topic or specific assignment, relevant media or documents will be provided as a handout or made available for downloading from the homepage of the chair.

Reading List:
A reading list will be made available by the chair.

Responsible for Module:
Graff, Uta; Prof. Dipl.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Tutorium Angewandte Darstellungstechnik (Übung, 2 SWS)
Graff U [L], Graff U, Rochelt H, Schmid P, Virsik J
For further information in this module, please click campus.tum.de or here.

Module Description

WI000285: Innovative Entrepreneurs - Leadership of High-Tech Companies | Innovative Entrepreneurs - Leadership of High-Tech Companies

Version of module description: Gültig ab summerterm 2021

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

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

Description of Examination Method:
The examination performance is achieved through individual project work, which is divided into three phases. In the first phase, the students intensely engage themselves over a period of six to eight weeks with a self-chosen "Inner Development Challenge" from one of the following topic areas: Relationship to Self, Cognitive Skills, Caring for Others and the World, Social Skills, and Driving Change. Subsequently, in the reflection phase, a written reflection paper is produced in which the students critically reflect on their experiences and draw conclusions for their future.
In the Peer feedback phase, the students read and analyze five reflection papers of their fellow students. This fosters the students' ability to critically analyze their own works as well as the works of others and to give and receive effective feedback.

Repeat Examination:
Next semester

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

Content:
The objective of the module is to inspire and motivate the participants coming from various disciplines for an entrepreneurial career, and to give them a basic understanding about founding and managing technology- and growth-oriented companies. To serve this purpose, the module provides an introduction to the topic of (effectual) entrepreneurship, as well as guest lectures by outstanding founders, entrepreneurs, managers, and investors on selected topics, such as:

1. The entrepreneurial ecosystem
2. Founding of companies for students and scientists
3. How to develop an idea into a market-ready product
4. Financing of startups
5. Corporate growth
6. Creating and managing an entrepreneurial culture
7. Strategic business management
8. Innovation management
9. Corporate finance
10. Business succession

Moreover, for self-motivated participants, there is ample opportunity for personal development through interactive workshops, closed networking events.

Intended Learning Outcomes:
Upon successful completion of this module, participants will be able to...
- understand the entrepreneurial mindset
- recognize and develop personal strengths
- develop and implement personal ideas
- understand Design Thinking methodology

Moreover through guest speakers' lectures and optional workshops participants will be empowered to:
- realize opportunities and challenges associated with the founding and managing of technology- and growth-oriented companies;
- create a personal roadmap for entrepreneurial success.

Thus, students familiarize with topics like opportunity recognition, innovation management, growth, leadership, and the facets of entrepreneurship. In doing that, they are enabled to see, realize, and experience the multiplicity in the everyday life of an entrepreneur, entrepreneurial personalities, as well as entrepreneurial skills and motivations.

Teaching and Learning Methods:
As guest lecturers, each week an outstanding founder, entrepreneur, manager, or investor, spanning a wide-ranging industrial spectrum, is hosted to report on their individual entrepreneurial careers.

At the end of each lecture, the participants can actively engage in discussions with the guest speaker during an open session.

Moreover, in context of a workshop, the participants venture their own personal qualities and skills to understand in a structured way their own entrepreneurial identity. In doing that, they focus on their individual strengths and resources to develop a plan to be entrepreneurial.

The module also provides participants with ample opportunity to network with people from the entrepreneurial environment of TUM.

Media:
- Lecture slides downloadable
- Online discussion forum (e.g., for questions and feedback on guest lectures)
- Handouts (distributed online)

Reading List:
Read, S., S arasvathy, S., Dew, N., Wiltbank, R., & Ohlsson, A. V. (2016). Effectual Entrepreneurship. Taylor & Francis

Responsible for Module:
Schönenberger, Helmut; Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Innovative Entrepreneurs - Leadership of High-Tech Companies (WI000285, englisch) (Vorlesung, 2 SWS)
Schönenberger H [L], Schönenberger H, Schuster C
For further information in this module, please click campus.tum.de or here.

Module Description

BGU900016: Partner University - Elective Module | Partneruniversität - Wahlmodul

Version of module description: Gültig ab summerterm 2015

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

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

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

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

Module Description

SOT10051: Introduction to Python | Introduction to Python

Version of module description: Gültig ab winterterm 2023/24

Module Level:	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 180	**Self-study Hours:** 120	**Contact Hours:** 60

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

Description of Examination Method:
Exam, Duration: 60 min

Repeat Examination:

(Recommended) Prerequisites:
-

Content:
In today's research landscape, Python has emerged as an indispensable tool for researchers across various disciplines. Its simplicity, versatility, and powerful libraries make it a preferred choice for data analysis, scientific computing, and research automation.

Throughout this course, we will explore the fundamental concepts of programming using Python as our primary language. You will see how to write clean, efficient, and reproducible code, enabling you to perform complex data analysis tasks, visualize research findings, and automate repetitive research processes.

Our hands-on approach ensures that you gain practical experience so that afterward you can apply Python programming techniques directly to your research domain. From working with data structures and implementing algorithms, you will obtain the basic skills necessary for later research challenges.

Moreover, we will delve into valuable Python libraries such as NumPy, Pandas, and Matplotlib, which are widely used in data analysis, machine learning, and visualization. You will discover how to leverage these tools to extract insights from complex datasets, analyze trends, and communicate your research findings effectively.

As a researcher, you understand the significance of reproducibility and the importance of transparent methodologies. This course will touch on documenting code, version control, and collaborating with colleagues, enhancing your collaborative research workflow.

Intended Learning Outcomes:
By the end of this course, participants will be able to understand the fundamental concepts and principles of the Python programming language. They will acquire the skills to write, debug, and execute Python code to solve basic computational problems. Participants will also gain proficiency in utilizing Python libraries and modules to perform tasks such as data manipulation, file handling, and data analysis.
This course is designed for beginners with no prior programming experience.

Teaching and Learning Methods:
This block course is designed to provide hands-on experience to participants, emphasizing active learning and practical exercises. Each lecture will focus on different aspects of Python including a short introduction to the material by the lecturer, followed by the following components: Individual/ Pair exercises to reinforce the learner's understanding of programming through hands-on practice. Live coding session with the lecturer to demonstrate programming techniques and best practices. Real-world tasks that the students will need to solve using all the techniques they have learned so far.

Media:
2 weekly hours of lecture are presented with Powerpoint slides. 2 weekly hours of exercise: students and lecturer collaboratively experiment with the code in class. Students have full access to all media via the Moodle page of the module.

Reading List:
Relevant online resources will be provided.

Responsible for Module:
Maquiling, Virmarie; M.Sc.

Courses (Type of course, Weekly hours per semester), Instructor:
Introduction to Python (Übung, 2 SWS)
Maquiling V [L], Maquiling V, Steinbauer F, Fastowski A
For further information in this module, please click campus.tum.de or here.

Module Description

AR20097: Lecture Series 2: Sustainable Building and Technologies | Lecture Series 2: Sustainable Building and Technologies

Version of module description: Gültig ab winterterm 2022/23

Module Level: Bachelor/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:
Two assignments have to be completed. The exercises will require students to investigate and discuss the presented topics. Attendance of the lecture is mandatory.

Repeat Examination:

(Recommended) Prerequisites:

Content:
The lecture series provides insights into fundamental issues of sustainable construction and shows the importance of the construction industry in terms of a resource-conserving approach towards the ecosystem Earth. Case studies of sustainable technologies, materials, components and buildings will be shown to demonstrate how aesthetic, functional, structural and environmental aspects with regard to the planning and implementation of sustainable buildings can be integrated into a holistic design process. This includes both the maintenance of existing buildings and the construction of new buildings.

Intended Learning Outcomes:
After having participated in the event, the students are able to recognize and understand the connection between ecological, socio-cultural and economic factors in terms of a sustainable approach in the construction industry. Based on the presentation of examples, students can reflect and understand the basic goals and procedures with regard to the planning of sustainable buildings. In addition, the students know the necessary approaches in design and planning to ensure a sustainable, resource-efficient use of materials, water and energy throughout the whole life-cycle of buildings.

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Ring 2: Sustainable Building and Technologies (Vorlesung, 2 SWS)
Wagner T [L], Auer T, Förster N, Hild A, Lang W, Musso F, Petzold F, Kohaus M, Wagner T, Zettelmeier C
For further information in this module, please click campus.tum.de or here.

Module Description

AR20131: Special Topics of Architectural History I | Sonderthemen der Architekturgeschichte I

Version of module description: Gültig ab winterterm 2019/20

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

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

Description of Examination Method:
Die Modulprüfung besteht aus einer Projektarbeit mit der die Studierenden ihre Ergebnisse dokumentieren und nachweisen, dass sie eine anwendungsorientierte Fragestellung und architekturtheoretische Themati-ken mit wissenschaftlichen Methoden unter Anleitung bearbeiten können.

Repeat Examination:

(Recommended) Prerequisites:
Die Studenten sollten Interesse an architekturgeschichtlichen Fragestellungen zeigen

Content:
Die Seminare beschäftigen sich mit bau- und architekturgeschichtlichen Themen des 20. und 21. Jahrhunderts. Um einen historisch reflektierten Zugang zur Architektur zu erhalten und um aus der Geschichte zu lernen, werden gesellschaftliche, politische, architekturtheoretische, ästhetische und baukonstruktive Aspekte an konkreten Beispielen behandelt, analysiert und thematisiert. Es geht um eine Sensibilisierung für historische Zusammenhänge auch bei der eigenen Entwurfstätigkeit.

Intended Learning Outcomes:
Nach der erfolgreichen Teilnahme an "Sonderthemen der Architekturgeschichte I" sind die Studierenden in der Lage
– architekturbezogene Problemstellungen zu analysieren und zu bewerten
– architektonische Themen und architekturtheoretische Zusammenhänge zu erkennen und darzulegen
– die historischen Zusammenhänge auf die eigene Entwurfsarbeit anzuwenden

– die eigene Arbeit wissenschaftlich nachvollziehbar schriftlich oder zeichnerisch darzulegen und zu kommunizieren

Teaching and Learning Methods:
Das Modul wird in seminaristischer Form durchgeführt. Die theoretischen Inhalte werden von Dozent/inn/en vermittelt und bei Bedarf durch Fachleute angereichert. Die Studierenden werden über das Studium der Literatur und die inhaltliche Auseinandersetzung mit den jeweiligen Themen aus dem Bereich der Architekturgeschichte vertraut gemacht. Durch Referate werden Inhalte und theoretischen Fragestellungen erörtert und am Ende des Semesters vertieft in schriftlicher Form abgegeben.

Media:
Regelmäßiger Übungsbetrieb mit Präsentationen und Einzelkritiken

Reading List:
Eine Literaturliste wird bezogen auf die Seminarthemen zu Beginn der Lehrveranstaltung bekanntgegeben und während des Seminars individuell empfohlen.

Responsible for Module:
Prof. Andres Lepik

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

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

Module Description

AR30181: Architecture and Reference | Architektur und Referenz

Version of module description: Gültig ab summerterm 2018

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

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

Description of Examination Method:
Die Prüfungsleistung des Moduls ist eine wissenschaftliche Ausarbeitung. Sie besteht aus Dokumentation (10 -20 Seiten bzw. 1-5 Pläne, 2 – 3 Modelle) und Präsentation einer Gebäudeanalyse. Durch eine differenzierte Untersuchung von einem herausragenden Bauwerk in Zeichnung und Modell in unterschiedlichen Maßstabsebenen sollen die Studierenden dokumentieren, dass sie komplexe Analysemethoden anwenden können, ein städtisches Gebäude in seinem Kontext einordnen können und die Ergebnisse veranschaulichen und dokumentieren können. Die Erkenntnisse der Analysearbeit sind am Ende des Semesters im Rahmen einer Schlusspräsentation vorzustellen und exemplarisch auf die eigene Entwurfsarbeit zu übertragen.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Es sind keine gesonderten Voraussetzungen notwendig. Das Fach kann von allen Studierenden im Masterstudiengang Architektur belegt werden. Das Fach bietet sich jedoch als Ergänzung zur Projektarbeit im Master an und ist in der Regel thematisch mit dem aktuellen Semesterthema der Projektarbeit verknüpft.

Content:
Im Rahmen des Moduls "Architektur und Referenz" erfolgt die Beschäftigung mit einem oder mehrerer herausragender Bauwerk(e) der älteren und jüngeren Architekturgeschichte. Sowohl auf theoretischer und architekturhistorischer als auch auf analytisch-zeichnerischer Ebene werden dabei die Bauten unter verschiedensten Gesichtspunkten seziert und sowohl das Gebäude als auch der dahinterliegende Entwurfsprozess analysiert.

Intended Learning Outcomes:
Nach Absolvierung des Moduls sind die Studierenden in der Lage:

- herausragende Referenzen in Form von Bauwerken mit Hilfe der entsprechenden architektonischen Analyse- und Darstellungsmethoden in unterschiedlichen Maßstabsebenen zu erfassen, zu veranschaulichen und zu dokumentieren.
- diese Referenzen hinsichtlich Einbindung in den architekturhistorischen und städtebaulichen Kontext, Konstruktion und Materialisierung zu verstehen und zu beschreiben.
- aus der Analysearbeit gewonnene Erkenntnisse zu identifizieren, diese zu adaptieren und auf eigene Entwurfsaufgaben anzuwenden.

Teaching and Learning Methods:
Mittels thematisch abgestimmten Impulsvorträgen werden die Modulinhalte betreffende Aspekte erörtert. Zudem werden die Studierenden mittels eigenen Kurzreferaten und - vorträgen trainiert, inhaltliche Erkenntnisse zu bündeln, darzustellen und zu präsentieren. Die Betreuung der Studierenden erfolgt in regelmäßigen Einzel- und Gruppenterminen. Zudem werden gemeinsame Zwischen und Schlußpräsentationen des jeweiligen Arbeitsstands bzw. Ergebnisses durchgeführt.

Media:
Beamerpräsentationen, Plan- und Modellpräsentationen, Gesprächsrunden, Tischgespräche

Reading List:
Modulbezogen wird im jeweiligen Semester themenbezogen Literatur ausgewählt und zu Beginn der Veranstaltung sowie individuell im Rahmen von Korrekturgesprächen empfohlen.

Responsible for Module:
Fink, Dietrich; Prof.

Courses (Type of course, Weekly hours per semester), Instructor:
Architektur und Referenz (Seminar, 4 SWS)
Fink D, Eder B, Hartmann J, Imhof S, Syren Z
For further information in this module, please click campus.tum.de or here.

Module Description

AR30294: Climate Responsive Building I | Klimagerechtes Bauen I

Version of module description: Gültig ab winterterm 2022/23

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:
Duration time 60 minutes. electronic lecture hall exam

In the exam the students proof that they are able to evaluate the complex correlation of climate responsive and energy optimized building. On the basis of practical examples it is examined that the students are able to create appropriate measures and concepts. Content is over the whole semester. Answers can be given in own words or given single-choice-questions. Furthermore basic calculations should be solved.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse der Gebäudetechnik, Kenntnisse über die Bilanzierung von Gebäuden in energetischer und
ökologischer Hinsicht.

Content:
- Climate and climatic parameters
- Fundamentals of energy and renewable energy
- Thermal comfort
- Climate responsive building: architecture strategies (passive) to optimize the building climate and energetic supply of buildings through an integrated planning approach
- Integration of building’s envelope and building technology (adjusting screw of the facade and adjustment of facade and room conditioning)
- Winter and summer insulation
- Energy balance of the building in heating and cooling mode
- Room conditioning: heating, cooling

- Technical building installation
- Energy conversion and energy supply, central and decentralised energy supply concept, energy storage
- Simulation tools
- Legal and energy economical framework

Intended Learning Outcomes:
At the end of the module climate responsive building students are able to
- design holistic, climate responsive and energy optimized building concepts
- create sustainable concepts of room conditioning and energy supply for buildings and quarters
- evaluate passive (architectural) measures for minimizing the energy demand of buildings while optimizing the comfort
- adapt individual technical systems of room conditioning to the building concept or coordinate the individual systems among themselves
- analyse practical examples with regard to climate responsive and energy optimized buildings
- understand the current political and scientific state of debate regarding to buildings and urban structures in the context of the energy revolution

Teaching and Learning Methods:
The practical relevance is established by current projects and students' discussion. In the weekly lectures the content of the module is mediated in form of lecture and presentation and tested in a written exam.

Media:
PowerPoint presentation, script, blackboard

Reading List:

Responsible for Module:
Vohlidka, Philipp; Dipl.-Ing. (Univ.)

Courses (Type of course, Weekly hours per semester), Instructor:
Klimagerechtes Bauen I (Vorlesung, 2 SWS)
Auer T, Koth S, Schmid T, Zettelmeier C
For further information in this module, please click campus.tum.de or here.

Module Description

BGU68010: Object-Oriented Programming for Transport Engineers | Objektorientiertes Programmieren für Verkehrsingenieure [Object-Oriented Programming for Transport Engineers]

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
In this course, students are expected to develop a simulation application as a project work on their own. Project themes and descriptions will be provided in class. Students must submit their code project and record a video of about 5-10 minutes explaining how they apply the OOP concept in their projects. In addition, students will be invited to a QA session to assess their understanding of OOP based on their projects in about 10 minutes. The code project accounts for 50% of the total grade, the video accounts for 25%, and the QA session accounts for the rest 25%.

Repeat Examination:

(Recommended) Prerequisites:
None

Content:
In this course, students will learn the object-oriented programming paradigm to address various transport problems. Students can choose from one of the two languages: Java or Python. This course will cover the following theoretical themes:
1. Programming language basics: data type, variable, control flow statements (if-else, and loop), method and testing
2. Design of object
3. Four principles of object-oriented programming: encapsulation, inheritance, polymorphism, and abstraction
4. Data containers
5. Read inputs and print outputs in .csv and .xml formats

Both Java and Python are powerful languages that are useful for transportation engineers students to learn. Your choice may be driven by your personal preference. Note that the class “Applied Transport Modeling with MATSim” requires Java knowledge, while the class “Microscopic Traffic Simulation - Calibration and Dynamic Applications” requires Python knowledge, which could be another criterion to select a programming language. Everything else being equal, TDM students often prefer Java while ITS students often prefer Python.

Intended Learning Outcomes:
After completing this course, students will have sufficient competencies to create applications in answering real-world transport-related questions in their study or future carrier. To be more specific, the students are able to:
1. memorize Java or Python language basics, such as data type, variables, control flow statements, methods, and testing
2. understand the design concept of object
3. describe the four principles of object-oriented programming
4. breakdown complex transport-related questions into multiple smaller programming tasks
5. evaluate the pros and cons of different object designs for their applications
6. identify suitable application design
7. read and write data for their applications
8. choose a suitable data container for their application
9. apply and reuse existing frameworks/packages when developing their applications

Please note that Java is recommended for the Applied Transport Modeling with MATSim course and Python for Microscopic Traffic Simulation - Calibration and Dynamic Applications. Both courses will be offered in the winter semester.

Teaching and Learning Methods:
This course is a lecture with integrated exercises. In the lecture part, PowerPoint presentation is the primary teaching method. Students will do the practical exercises with one to two peers in the exercise part. This teaching method enhances students’ ability to communicate, lead and participate in the discussion, synthesize consensus and presentation skills in a group. We will also open discussion forums in Moodle to let students ask questions and exchange ideas.
The workload of this course includes at least 4 study units per week during the lecture and two additional self-studying study units per week after the class.

Media:
- PowerPoint Presentations
- IntelliJ Java integrated development environment for Java or PyCharm for Python (IDE)

Reading List:
For Java: Sierra K., Bates B., Head First Java, O’Reilly & Associates Inc, Sebastopol, 2005.
For Python: “Think Python” by Allen B. Downey or "Introduction to computation and programming using Python" by John V. Guttag

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

Courses (Type of course, Weekly hours per semester), Instructor:
Object-Oriented Programming for Transport Engineers (Seminar, 4 SWS)
Huang W [L], Huang W, Ji J, Dandl F, Cai Y
For further information in this module, please click campus.tum.de or here.

Module Description

BGU900017: Partner University - Elective Module | Partneruniversität - Wahlmodul

Version of module description: Gültig ab winterterm 2015/16

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

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

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

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

Module Description

BGU900018: Partner University - Elective Module | Partneruniversität - Wahlmodul

Version of module description: Gültig ab winterterm 2019/20

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

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

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

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

Module Description

BV000075: Real Estate Management I | Immobilienmanagement I [PV2]

Version of module description: Gültig ab winterterm 2023/24

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 2	**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:
Schriftliche Prüfung 60 Minuten

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Vorlesung Grundstückswertermittlung,
Basiskenntnisse der Grundstückswertermittlung,
Basisrechenarten

Content:
Die Vorlesung setzt auf der Modulveranstaltung Grundstückswertermittlung auf. Vorhandene Basiskenntnisse über Grundstückswertermittlung werden in dieser vertieft und erweitert. Hierzu werden die Wertermittlungsverfahren nach ImmoWertV anhand von Praxisbeispielen erarbeitet und angewendet. Darüber hinaus werden folgende Themen behandelt:
- Umfassendes Verständnis des periodisches Ertragswertverfahren und Abgrenzung zum angelsächsischen Discounted-Cashflow-Verfahren
- Überblick über besondere objektspezifische Grundstücksmerkmale und Verfahrensansätze (z.B. besondere Ertragsverhältnisse, Baumängel/Bauschäden, Rechte und Belastungen), zur Erkennung und Anwendung durch die Studierenden.
- Grundständiges Wissen über Sonderfälle der Bodenwertermittlung
- Basiskenntnisse über nicht normierter Wertermittlungsverfahren (z.B. Residualwertverfahren)

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage, die
- Wertermittlungsverfahren nach ImmoWertV fallorientiert anzuwenden und
- Lösungsansätze für komplexere Bewertungsaufgaben zu entwickeln.

Teaching and Learning Methods:
Als Lehrformat werden Vorlesungen, unterstützt durch verschiedene Medienformen abgehalten. Es werden theoretische Inhalte und deren praktische Anwendung in der Grundstückswertermittlung vermittelt. Praktische Berechnungen und Anwendungsfälle werden zum besseren Verständnis seminaristisch (interaktiv) vermittelt. In den Vorlesungen wird auf Rückfragen und die eigenständige Erarbeitung von Lehrinhalten besonderen Wert gelegt.
Die Lehrmethoden sind auf die Lernaktivitäten Materialrecherche, Studium von Literatur und Auswendiglernen ausgerichtet.

Media:
Medienformen Präsentationsfolien und -dokumente mit Begleitliteratur

Reading List:
Kleiber (2023): Verkehrswertermittlung von Grundstücken, Kommentar und Handbuch, Köln: Reguvis Fachmedien
Sommer, Kröll (2022): Lehrbuch zur Immobilienbewertung, Köln: Werner Verlag

Responsible for Module:
Bendzko, Tobias

Courses (Type of course, Weekly hours per semester), Instructor:
Immobilienmanagement 1 (Vorlesung, 2 SWS)
de Vries W [L], Schaper D (Bendzko T)
For further information in this module, please click campus.tum.de or here.

Module Description

BV130105: Construction Management | Bauprozessmanagment: Grundlagen, Sicherheitstechnik [BPM-LA]

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:
The examination consists of a test (eventually as remote online exam) where the students prove not only their understanding of the learning content but also their ability to apply the methods, evaluate the results and consequences and moreover to develop the given approaches for further fields of utilization. Admissible auxiliary materials will be announced in the lecture. The test requires partly the student's own formulations, partly the qualifiedly checking of predefined statements.

Repeat Examination:

(Recommended) Prerequisites:
none

Content:
Interaction of Investors, Planning Engineers and Civil Engineering Industry, Processes of Planning, HOAI, DIN276, DIN277, VOB, Basic Contract Types; Basic Costing; Construction Management based on Processes; Quotation Costing; Planning of Production Processes; Fundamental Scheduling Techniques, Project Preparation and Production Engineering; Elementary Construction Methods

Intended Learning Outcomes:
Having successfully completed the module the students will have understood the given learning content and will be able to apply and develop this further. Therewith, they know to analyze and evaluate applicable situations and solve respective problems when later professionally working.

Teaching and Learning Methods:
The learning content is taught via lectures. Integrated supervised exercises and tutorials allow deepening this with the help of examples in interaction with the students. References to professional practice are maintained also by contributions of guest lecturers.

Media:
Lecture notes, power point-presentations, partially use of black/whiteboard, videoclips, excursions

Reading List:
Detailed lecture notes

Responsible for Module:
Zimmermann, Josef; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Bauprozessmanagement für Lehramt (Vorlesung mit integrierten Übungen, 4 SWS)
Eber W [L], Eber W
For further information in this module, please click campus.tum.de or here.

Module Description

BV470003: Harmonisation of Geospatial Data | Geodatenharmonisierung

Version of module description: Gültig ab summerterm 2020

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

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

Description of Examination Method:
The expected learning outcomes are verified by an oral examination (30 minutes). The examination is to provide evidence that the students
- understand the methods for the harmonisation of geospatial data introduced in the module,
- are able to analyse use cases from the field of Geodesy and Geoinformation and
- are able to develop corresponding ETL processes.
The documentation of the ETL process the students develop within this module is an authorised learning aid during the examination.

Note in view of the limitations on university operations as a result of the CoViD19 pandemic: If the basic conditions (hygiene, physical distance rules, etc.) for a classroom-based examination cannot be met, the planned form of examination can be changed to a written or oral online examination in accordance with §13a APSO. The decision about this change will be announced as soon as possible, but at least 14 days before the date of the examination by the examiner after consultation with the board of examiners of the respective study program.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fundamentals of Geoinformatics.

Content:
The module focuses on imparting knowledge about the harmonisation of geospatial data. The content of the module is structured as follows:
- Introduction to the technical terms related to geospatial data harmonisation
- Syntactic and semantic heterogeneity of geospatial data
- Geospatial data harmonisation in the context of spatial data infrastructures

- Selected methods of geospatial data harmonisation (selected semantic transformation methods, selected geometric transformation methods)
- Spatial ETL (Extract Transform Load) with the software FME

Intended Learning Outcomes:
After successful completion of the module students are able
- to understand the use of geodata harmonisation methods, e.g. spatial ETL (Extract, Transform, Load), for the combined usage of heterogeneous geospatial data from distributed systems, generally in the Geoinformatics domain and in the context of spatial data infrastructures (SDI),
- to apply a spatial ETL tool (software FME),
- to analyse use cases in the geodesy and geoinformation domain (e.g. semantic transformation in spatial data infrastructures, integration of measurement data or data from architecture and construction into GIS),
- to develop ETL processes for selected use cases.

Teaching and Learning Methods:
Lectures for imparting the theoretical foundations and the basic functions of a spatial ETL tool.
Exercises for gaining practical skills in applying the methods introduced in the lectures.
Development of an ETL process for solving a selected use case of geospatial data harmonisation as part of the self-study hours.

Media:
presentations,
software FME.

Reading List:
provided by the lecturers/supervisors

Responsible for Module:
Thomas H. Kolbe (thomas.kolbe@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Geodatenharmonisierung (Übung, 2 SWS)
Donaubauer A
For further information in this module, please click campus.tum.de or here.

Module Description

CLA11317: Interdisciplinary Lecture Series Environment: Politics and Society | Ringvorlesung Umwelt: Politik und Gesellschaft

Version of module description: Gültig ab summerterm 2015

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 1	**Total Hours:** 30	**Self-study Hours:** 15	**Contact Hours:** 15

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

Description of Examination Method:
A successful accomplishment of 9 academic performances is mandatory for the examination!
The examination consists of a short PowerPoint presentation at the end of the semester. The presentation can be created alone or in groups of two. Everyone has to speak one minute.
The examination is ungraded.

Repeat Examination:

(Recommended) Prerequisites:

Content:
The lecture series Umwelt (environment) is an interdisciplinary, public lecture organised by the Environmental Department of the Studentische Vertretung (Student Representatives) of the TU Munich. Experts speak e.g. on technical environmental protection, health, consumer and climate protection. In the summer semester, it offers students the opportunity to learn about the political and social dimensions of current ecological topics and research results at a scientific level.

The lecture series Umwelt (environment) is offered in the winter semester in the module CLA11200 Ringvorlesung Umwelt: Ökologie und Technik (Lecture series on the environment: ecology and technology). It is only possible to gain given credits twice for the lecture series within each study program.

Intended Learning Outcomes:
Students are able to follow expert presentations on political and social dimensions of environmental problems and identify core theses and central facts.

Teaching and Learning Methods:
Lectures, presentations, discussions

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Cities of Change: Unleashing the Power of Sustainable Solutions (Ringvorlesung Umwelt) (Vorlesung mit integrierten Übungen, 1,5 SWS)
Nogueira de Carvalho M, Reim L, Slanitz A
For further information in this module, please click campus.tum.de or here.

Module Description

EI04004: Strategic Management for Engineers | Strategic Management for Engineers

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
The examination is done in a written exam (60 min) at the end of the semester. Considering the learning objectives the theoretical and practial concepts of strategic management will be covered. The students have to explain notions, concepts, methods and the background of the covered topics. In addition, the students discuss different solutions of specific practical problems from the entrepreneurial practise.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
No requirements

Content:
Introduction
- Strategic purpose (vision, mission, values; stakeholders)
- Ownership models, Corporate social responsibility (CSR) and compliance
- Shareholder value

Strategic positioning
- Business environment
- Resources, competencies and strategic capabilities
- Value chain and value system

Business strategy
- Strategic business units
- Competitive strategies (cost leadership, differentiation)

Corporate strategy
- Value creation and the corporate parent
- Portfolio management

Digitalization
- Technological achievements, new business models and social attractiveness
- Platforms
- Big data

Technology and Innovation

Internationalization

Mergers, acquisitions and alliances

Organization of companies

Strategy planning process

Business plans

Intended Learning Outcomes:
After successful completion of the module students have an overview on how strategic planning and decision-making processes are carried out in companies. They know the prerequisites (in addition to a suitable product or a suitable business idea) that are necessary in order to successfully position a business in the market. In addition, they are able to evaluate products or business ideas, taking into account the market environment and the competitive situation. They are closer to being able to prepare sound management decisions.

Teaching and Learning Methods:
The lecture is accompanied by intense dicussions about pros and cons of specific strategy tools. There will be also discussions about case studies of specific companies.

Media:
Power Point Slides, Animations, Blackboard

Reading List:
Recommended literature:
Gerry Johnson: Exploring Strategy - Text and Cases

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

Courses (Type of course, Weekly hours per semester), Instructor:
Strategic Management for Engineers (Vorlesung, 2 SWS)
Hepp A [L], Sauerbrey J
For further information in this module, please click campus.tum.de or here.

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, Kempf M, Sattler P, Steger L
For further information in this module, please click campus.tum.de or here.

Module Description

IN8003: Introduction to Informatics | Informatik

Version of module description: Gültig ab summerterm 2017

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:
Type of Assessment: exam
The exam takes the form of written 60 minutes test. Knowledge questions allow to assess acquaintance with and understanding of the basic concepts of Computer Science. Small programming and modelling problems allow to assess the ability to practically apply the learned programming- and query-languages and modelling-techniques for the solution of small problems.

In case of epidemiologic emergencies, the exam may be substituted by a graded electronic exercise or a proctered exam.

If very few students register for the exam, the exam may (after consulting the students) be optionally be held as an oral exam.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Recommended requirements are Mathematics modules of the first year of the participating bachelor's programs.

Content:
The module is concerned with topics such as:
- Database Management Systems,.ER models, Relational Algebra, SQL
- Java as a programming language:
++ basic constructs of imperative programming (if, while, for, arrays etc.)
++ object-oriented programming (inheritance, interfaces, polymorphism etc.)
++ basics of Exception Handling and Generics
++ code conventions

++ Java class library
- Basics of Visual Basic for Applications
- Basic algorithms and data structures:
++ algorithm concept, complexity
++ data structures for sequences (arrays, doubly linked lists, stacks & queues)
++ recursion
++ hashing (chaining, probing)
++ searching (binary search, balanced search trees)
++ sorting (Insertion-Sort, Selection-Sort, Merge-Sort)

Intended Learning Outcomes:
Upon successful completion of the module, participants understand important foundations, concepts and ways of thinking of Computer Science, in particular object-oriented programming, databases and SQL, and basic algorithms and data structures, have an overview over these topics and be able use them for the development of own programs with a link to a database in a basic way.

Teaching and Learning Methods:
Lecture and practical central tutorial: In the central tutorial deepens the understanding of the concepts introduced in the lecture and teaches practical programming skills using example assignments. Lecture and central tutorial are very closely linked. Homework assignments are provided which are intended to be solved autonomously and intended to practice the practical programming and modeling skills, in order to be able to apply the knowledge acquired by self-study of the accompanying materials of lecture and central tutorial for autonomously solving small problems.

Media:
Slides, blackboard, lecture- and central tutorial recording, discussion boards in suitable e-learning platforms

Reading List:
Chapters from textbooks, which are closely associated with the module content and are provided to the students online.

Responsible for Module:
Groh, Georg; Prof. Dr. rer. nat. habil.

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die Informatik für andere Fachrichtungen (IN8003) (Vorlesung mit integrierten Übungen, 4 SWS)
Groh G
For further information in this module, please click campus.tum.de or here.

Module Description

MGT001354: Artificial Intelligence for Innovation and Entrepreneurship | Artificial Intelligence for Innovation and Entrepreneurship

Version of module description: Gültig ab winterterm 2024/25

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

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

Description of Examination Method:
Practice Work (Übungsleistung): This is an integral part of the learning and assessment process, designed to ensure that students engage deeply with the content presented during the lectures and mandatory readings. It will consist of the following component:

Online Multiple-Choice Quiz (100%): This will be conducted at the end of the semester, allowing students to test their understanding and retention of the course content in accordance with the learning outcomes. Students will get a serious of question based on the required readings and content discussed in class.

Note: Based on the course evaluation and feedback from the previous year, we have decided to remove the peer-reviewed assignments to ensure the course workload corresponds to 3 ECTS.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
No prior knowledge or specific skills are required for the successful completion of the 'AI for Innovation and Entrepreneurship' course. This module is constructed to be universally accessible, encompassing a broad spectrum of learners irrespective of their educational background. Whether you possess a technical or non-technical background, this course is suitable for all backgrounds. No prior coding or mathematical experience is needed. All students who are curious and ambitious to harness the transformative power of AI are encouraged to participate.

Content:
In the "AI for Innovation and Entrepreneurship" course, we employ a range of dynamic teaching and learning methods that not only deliver a comprehensive understanding of AI and its practical applications in the real world but also promote mindfulness and trustworthiness.

The course follows an engaging lecture style, utilizing storytelling, real-world examples, and case studies to make complex AI concepts tangible and relatable. These methods provide students with an in-depth understanding of the subject matter.

Each lecture, lasting between 60 to 90 minutes, incorporates interactive elements such as Slido for real-time participation, quizzes, and in-class surveys, promoting an active learning environment.

Furthermore, we appreciate the importance of a balanced learning experience. Therefore, we intersperse lectures with short mindfulness exercises. These practices aim to improve focus, reduce stress, and enhance the overall learning experience, creating a harmonious learning environment.

In addition to theoretical learning, we host short keynotes by field experts, organizational leaders, and startup pioneers to provide students with real-world insights into AI. This balance of theory and practice offers a well-rounded view of the field, aiding in the students' understanding and appreciation of AI.

Complementing the lectures, online exercises, readings and case studies allow students to apply the concepts they've learned, reinforcing their understanding and enabling them to independently handle real-world scenarios.

Intended Learning Outcomes:
Upon successful completion of the "AI for Innovation and Entrepreneurship" course, students will be able to:
1. Understand and Explain AI Fundamentals:
* Describe core AI concepts, including machine learning methodologies and trustworthiness principles.
* Explain the state of the art in AI and its key principles.
2. Apply AI in Practice:
* Implement AI use cases in both existing organizations and startups.
* Assess opportunities for AI applications, identify technical and business requirements, and address potential challenges effectively.
3. Develop Entre-/Intrapreneurial Competence:
* Formulate strategies for establishing and leading AI startups and AI initiatives in an organizational setting.
* Identify promising AI use cases and realize them in a business context.
4. Demonstrate Organizational Leadership:
* Create effective AI strategies tailored to different organizational settings.

* Critically evaluate the nuances of AI integration in various sectors and navigate the challenges of becoming an AI-first organization.
5. Evaluate Societal, Ethical and Regualtory Implications:
* Examine the societal impact of AI, considering both its transformative potential and ethical challenges.

Through this course, students will not only broaden their knowledge of AI but also enhance their problem-solving, strategic thinking, and entrepreneurial skills. This combination will position them to become influential actors and innovators in the rapidly evolving AI landscape, irrespective of their academic background.

Teaching and Learning Methods:
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Complementing the lectures, online exercises, readings and case studies allow students to apply the concepts they've learned, reinforcing their understanding and enabling them to independently handle real-world scenarios.

Media:
In the "AI for Innovation and Entrepreneurship" course, we utilize a variety of media resources to enhance the learning experience and ensure comprehensive understanding of AI concepts. This includes:

- PowerPoint Presentations: For the structured delivery of lectures and discussions.

- Slack: As a communication tool, offering an avenue for discussions, collaboration, and sharing resources outside of classroom hours.
- Code Examples: For practical demonstrations and hands-on learning.
- Journal Articles & Textbooks: For deeper study and understanding of AI concepts and applications.
- Videos: For visual learning and better understanding of complex concepts.
- Newspaper Articles: To keep students informed about current trends and developments in AI.
- Twitter Posts & TikToks: To engage with contemporary discussions on AI and technology and connect learning to the real world.
- Surveys: To gather student feedback and assess understanding and progress.

By combining traditional teaching methods with modern, digital tools, we create an inclusive and immersive learning environment that caters to diverse learning preferences. This approach enriches the course content, ensuring it remains exciting, relevant, and engaging.

Reading List:
Indicative readings

Acemoglu, D. (2021). Redesigning AI. Boston Review/Boston Critic Inc.
Agrawal, A., Gans, J., & Goldfarb, A. (2018). Prediction Machines: The Simple Economics of Artificial Intelligence. Harvard Business Press.
Berente, N., Gu, B., Recker, J., & Santhanam, R. (2021). Managing Artificial Intelligence. MIS Quarterly, 45(3), 1433-1450.
Brynjolfsson, E., & McAfee, A. (2017). Artificial Intelligence, for Real. Harvard Business Review.
Crawford, K. (2021). The Atlas of AI: Power, Politics, and the Planetary Costs of Artificial Intelligence. Yale University Press.
Hosanagar, K. (2020). A Human’s Guide to Machine Intelligence: How Algorithms Are Shaping Our Lives and How We Can Stay in Control (Illustrated edition). Penguin Books USA.
Iansiti, M., & Lakhani, K. R. (2020). Competing in the Age of AI: Strategy and Leadership When Algorithms and Networks Run the World (Illustrated edition). Harvard Business Review Press.
Kellogg, K. C., Valentine, M. A., & Christin, A. (2020). Algorithms at Work: The New Contested Terrain of Control. Academy of Management Annals, 14(1), 366-410.
Raisch, S., & Krakowski, S. (2021). Artificial Intelligence and Management: The Automation–Augmentation Paradox. Academy of Management Review, 46(1), 192-210.
Provost, F., & Fawcett, T. (2013). Data Science for Business: What You Need to Know about Data Mining and Data-Analytic Thinking. O’Reilly Media, Inc.

Responsible for Module:
Tryba, Anne; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Artificial Intelligence for Innovation and Entrepreneurship (MGT001354, englisch) (Seminar, 2 SWS)
Post T

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

Module Description

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

Version of module description: Gültig ab winterterm 2023/24

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

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

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

Repeat Examination:
Next semester

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

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

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

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

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

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

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

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

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

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

Media:

Reading List:

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

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

Module Description

SZ0303: German as a Foreign Language A2.1 | Deutsch als Fremdsprache A2.1

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/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:
Performance, testing the learning outcomes specified in the module description, is examined by a cumulative portfolio of competence and action-oriented tasks. Aids are permitted.
The examination performances are designed in their entirety to test the use of vocabulary and grammar, reading and/or listening comprehension, and free text production.
Oral communication skills will be tested via the use of appropriate idioms in written dialogue examples and/or in the form of an audio/video file. For this purpose, we observe the Basic Data Protection Regulation (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
assured knowledge of level A1.2; placement test with result A2.1

Content:
This module teaches basic knowledge of German as a Foreign Language, taking into account intercultural and cultural aspects of the country, enabling students to cope in simple, routine situations, e.g. when traveling, at the doctor's, looking for an apartment, in the department store, among colleagues, friends and neighbors.
They will learn/practice vocabulary/expressions on topics such as study and training, work, housing, media, and travel. They learn/practice using basic main and subordinate clauses (e.g. dass, weil, und, denn, etc.), reporting in the past tense (modal verbs) and perfect tense, the use of the comparative and superlative forms, and the declension of the adjective. They review and expand the use of prepositions in the accusative and dative.

Intended Learning Outcomes:
The module is oriented towards level A2 of the CEFR.
After completing this module, students will be able to understand and use simple sentences, phrases and idiomatic expressions in conversations on an extended range of familiar topics, such as basic information on everyday topics or topics relevant to studies or work, including cultural aspects of the country.
They can, for example, describe themselves and other people, personal living situation, state of health, leisure activities and basic work-related situations.
Students can understand longer texts and letters on familiar topics using common but simple everyday or work-related language and containing predictable information. They can write short, informative texts or messages on basic situations in everyday life and study.

Teaching and Learning Methods:
The module consists of a seminar in which students study the learning content with targeted listening, reading, writing and speaking exercises. The communicative and action-oriented approach is implemented by combining these exercises in individual, partner and group exercises. Online material for controlled self-study of basic grammatical phenomena and communication patterns is provided to deepen and intensify the content taught during the course. Voluntary homework (for preparation and revision) consolidates what has been learned.

Media:
Textbook; multimedia-supported teaching and learning material, also online.

Reading List:
Textbook: will be announced in the course

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache A2.1 (Seminar, 4 SWS)
Aßmann J, Comparato G, Dechant S, Detcheva-Knippelmeyer I, Körner C, Kostial M, Kummer-Rock A, Lebling-Gemaljevic J, Meuschel G, Mielert A, Schmidt-Bender S

Deutsch als Fremdsprache A2.1 - EuroTeQ (Seminar, 4 SWS)
Kostial M
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0304: German as a Foreign Language A2.2 | Deutsch als Fremdsprache A2.2

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/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:
In den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Die Prüfungsleistungen werden in Form von kompetenz- und handlungsorientierten (Portfolio-) Prüfungsaufgaben erbracht. Hilfsmittel sind erlaubt.
Die Prüfungsleistungen sind in ihrer Gesamtheit so konzipiert, dass die Anwendung von Wortschatz und Grammatik, das Lese- und/oder Hörverstehen sowie die freie Textproduktion geprüft werden.
Mündliche Kommunikationsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
gesicherte Kenntnisse der Stufe A2.1; Einstufungstest mit Ergebnis A2.2

Content:
In diesem Modul werden Grundkenntnisse in Deutsch als Fremdsprache unter Berücksichtigung interkultureller und landeskundlicher Aspekte vermittelt, die es den Studierenden ermöglichen, sich in einfachen, routinemäßigen Situationen zurechtzufinden, z.B. auf Reisen, beim Arzt, auf Wohnungssuche, im Kaufhaus, unter Kollegen, Freunden und Nachbarn.
Sie wiederholen und ergänzen grundlegendes Vokabular /Ausdrucksmöglichkeiten zu Themen wie Ausbildung, Beruf, Wohnen, Freizeit und Mobilität. Sie lernen/üben ein erweitertes Spektrum an Haupt- und Nebensätzen (z.B. indirekte Frage, temporaler Nebensatz) sowie den Konjunktiv II zu benutzen und sie wiederholen bzw. erweitern den Gebrauch der Präpositionen.

Es werden Möglichkeiten aufgezeigt, den Lernprozess eigenverantwortlich effektiver zu gestalten und damit die eigene Lernfähigkeit zu verbessern. Die Studierenden üben Teamkompetenz durch kooperatives Handeln in multinational gemischten Gruppen.

Intended Learning Outcomes:
Das Modul orientiert sich am Niveau A2 des GER.
Nach Abschluss dieses Moduls sind die Studierenden in der Lage im Gespräch einfache Sätze und Redewendungen zu einem erweiterten Spektrum an vertrauten Themen zu verstehen und zu gebrauchen. Dabei handelt es sich um grundlegende Informationen zu alltäglichen, oder studien- bzw. berufsrelevanten Themen unter Einbeziehung landeskundlicher Aspekte.
Sie können beispielsweise sich und andere Personen, die persönliche Wohnsituation, Gesundheitszustand, Freizeitverhalten und berufliche Situation im Präsens oder Perfekt beschreiben. Sie können Vorschläge machen und reagieren, Informationen austauschen und Ratschläge geben.
Die Studierenden können längere Texte und Briefe zu vertrauten Themen verstehen, in denen gängige aber einfache alltags- oder berufsbezogene Sprache verwendet wird und in denen vorhersehbare Informationen zu finden sind. Sie sind in der Lage kurze, informative Texte oder Mitteilungen zu grundlegenden Situationen in Alltag und Studium zu verfassen.

Teaching and Learning Methods:
Das Modul besteht aus einem Seminar, in dem die angestrebten Lerninhalte mit gezielten Hör-, Lese, Schreib- und Sprechübungen erarbeitet werden. Durch die Kombination dieser Übungen in Einzel-, Partner- und Gruppenarbeit wird der kommunikative und handlungsorientierte Ansatz umgesetzt. Durch kontrolliertes Selbstlernen grundlegender grammatischer Phänomene und Kommunikationsmuster in der Fremdsprache mit vorgegebenen (online-) Materialien werden die im Seminar vermittelten Grundlagen vertieft.
Freiwillige Hausaufgaben (zur Vor- und Nacharbeitung) festigen das Gelernte.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial, auch online

Reading List:
Lehrbuch: wird im Kurs bekannt gegeben

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache A2.2 (Seminar, 4 SWS)
Aßmann J, Comparato G, Dechant S, Feistle C, Grigorieva A, Hagner V, Körner C, Kovacs O, Kummer-Rock A, Steidten R, Thiessen E
For further information in this module, please click campus.tum.de or here.

Module Description

SZ03041: Intensive Course German as a Foreign Language A2.2 | Blockkurs Deutsch als Fremdsprache A2.2

Version of module description: Gültig ab winterterm 2015/16

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 4	**Total Hours:** 120	**Self-study Hours:** 60	**Contact Hours:** 60

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

Description of Examination Method:
1 final exam 90 min. (100%) - no learning aids permitted
The midterm exam is intended to monitor students' learning progress and reduce the amount of material covered in the final exam. Written exams will assess students level of acquisition of the learning outcomes specified in the module description. Specifically, exam questions focus on the usage of vocabulary and grammar, as well as reading comprehension and text production. Listening comprehension is tested by posing questions based on audio samples to which students respond in writing.
Verbal skills are evaluated using appropriate prompts from sample print dialogs.

Repeat Examination:

(Recommended) Prerequisites:
Firm knowledge of level A2.1; placement test with the achievement A2.2

Content:
In this module, students acquire basic knowledge of the German language, including intercultural and regional aspects, that will enable them to express themselves in everyday situations, such as traveling, at the doctor’s office, searching for an apartment, in a department store, among colleagues, friends or neighbors.
Students reinforce and augment basic vocabulary and expressions on topics such as education, profession, living and traveling. Students learn and practice classifying and using an extended spectrum of main and subordinate clauses (final clause, indirect questions, temporal subordinate clause, causal sentence). They also learn to employ the preterit (modals verbs) and perfect and will repeat and expand the usage of the prepositions and the declination of the adjective.

Students learn strategies for successful verbal and written communication despite minimal language skills. Opportunities will be made available for effective, self-motivated, independent learning. Students acquire teamwork skills through collaborative work in multinational mixed groups.

Intended Learning Outcomes:
The module is based on level A2 of GER.
Upon completion of this module, students are able to understand and use simple sentences and expressions in conversations on a broad spectrum of familiar topics. These conversations are based on basic information concerning everyday life and subjects relevant to studying or working, including sociocultural aspects of German-speaking countries.
For example, students are able to describe themselves and other people, their living situation, state of health, leisure time activities and job situation. Students are able to communicate in various situations, for example, when searching for an apartment, traveling or on holiday, and are able to report about their experiences in simple standard language.
Students are able to understand longer texts and letters about familiar topics that include foreseeable information and are written in simple language about everyday life or job related topics. Students are able to compose short, informative texts or notifications about basic situations in everyday life or situations related to studying.

Teaching and Learning Methods:
The module consists of a seminar covering material appropriate to desired learning outcomes and encompassing relevant listening, reading, writing and speaking exercises. These exercises may take the form of individual, partner or group work, implementing a communicative and activity-oriented approach. Students have the opportunity to deepen basic knowledge conveyed in the seminar through independent study and work, using specified (online) materials covering fundamental grammar and communication patterns of the foreign language.
Voluntary homework (preparation and follow-up work) reinforces classroom and structured learning.

Media:
Textbook; multimedia-based teaching and learning materials (black board, overheads, exercise sheets, image, film, etc.) also online

Reading List:
Textbook (to be announced in class)

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Blockkurs Deutsch als Fremdsprache A2.2 (Seminar, 4 SWS)
Steidten R
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0321: German as a Foreign Language A1.1 plus A1.2 | Deutsch als Fremdsprache A1.1 plus A1.2

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 8	**Total Hours:** 270	**Self-study Hours:** 180	**Contact Hours:** 90

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

Description of Examination Method:
In den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Die Prüfungsleistungen werden in Form von kompetenz- und handlungsorientierten (Portfolio-) Prüfungsaufgaben erbracht.
Hilfsmittel sind erlaubt.
Die Prüfungsleistungen sind in ihrer Gesamtheit so konzipiert, dass die Anwendung von Wortschatz und Grammatik, das Lese- und/oder Hörverstehen sowie die freie Textproduktion geprüft werden.
Mündliche Kommunikationsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
keine

Content:
In diesem Modul werden Grundkenntnisse in Deutsch als Fremdsprache unter Berücksichtigung interkultureller und landeskundlicher Aspekte vermittelt, die es den Studierenden ermöglichen, sich trotz geringer Sprachkenntnisse z.B. beim Einkaufen, im Restaurant, im öffentlichen Verkehr etc. zurechtzufinden.

Sie lernen/üben grundlegendes Vokabular zu Themen wie Familie, Beruf, Freizeit, Einkaufen, Wohnen, Reisen und Gesundheit, einfache Gespräche in alltäglichen Situationen zu führen und in Hauptsätzen Alltägliches im Präsens und Perfekt zu berichten, unter Verwendung von Nomen,

Verben, Pronomen und Possessivartikeln, Modalverben, Imperativ und grundlegender lokaler und temporaler Präpositionen.
Es werden Möglichkeiten aufgezeigt, den Lernprozess in der Fremdsprache eigenverantwortlich und effektiv zu gestalten. Die Studierenden üben Teamkompetenz durch kooperatives Handeln in multinational gemischten Gruppen.

Intended Learning Outcomes:
Das Modul orientiert sich am Niveau A1 des GER.
Nach Abschluss dieses Moduls sind die Studierenden in der Lage alltägliche Ausdrücke und einfache Sätze zu verwenden, die auf die Befriedigung konkreter, in der Bewältigung des Alltags wesentlicher Bedürfnisse zielen:
Sie können einfache Fragen in alltäglichen Situationen stellen und beantworten, Tagesabläufe in Vergangenheit und Gegenwart beschreiben und einfache schriftliche Mitteilungen zur Person machen, Verabredungen treffen und in grundlegenden alltäglichen Situationen beispielsweise beim Einkauf oder im Restaurant ihre Wünsche erfolgreich kommunizieren, wenn die Gesprächspartner langsam und deutlich sprechen und bereit sind zu helfen.

Teaching and Learning Methods:
Das Modul besteht aus einem Seminar, in dem die angestrebten Lerninhalte mit gezielten Hör-, Lese-, Schreib- und Sprechübungen erarbeitet werden. Durch die Kombination dieser Übungen in Einzel-, Partner- und Gruppenarbeit wird der kommunikative und handlungsorientierte Ansatz umgesetzt. Durch kontrolliertes Selbstlernen grundlegender grammatischer Phänomene und Kommunikationsmuster in der Fremdsprache mit vorgegebenen (online-) Materialien werden die im Seminar vermittelten Grundlagen vertieft.
Freiwillige Hausaufgaben (zur Vor- und Nacharbeitung) festigen das Gelernte.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial, auch online

Reading List:
Lehrbuch: wird im Kurs bekannt gegeben

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache A1.1 plus A1.2 (Seminar, 6 SWS)
Nierhoff-King B, Schlüter J
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0322: German as a Foreign Language A2.1 plus A2.2 | Deutsch als Fremdsprache A2.1 plus A2.2

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	Language: German	Duration: one semester	Frequency: winter/summer semester
Credits:* 8	**Total Hours:** 270	**Self-study Hours:** 180	**Contact Hours:** 90

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

Description of Examination Method:
In den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Die Prüfungsleistungen werden in Form von kompetenz- und handlungsorientierten (Portfolio-) Prüfungsaufgaben erbracht.
Hilfsmittel sind erlaubt.
Die Prüfungsleistungen sind in ihrer Gesamtheit so konzipiert, dass die Anwendung von Wortschatz und Grammatik, das Lese- und/oder Hörverstehen sowie die freie Textproduktion geprüft werden.
Mündliche Kommunikationsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
gesicherte Kenntnisse der Stufe A1.2; Einstufungstest mit Ergebnis A2.1

Content:
In diesem Modul werden Grundkenntnisse in Deutsch als Fremdsprache unter Berücksichtigung interkultureller und landeskundlicher Aspekte vermittelt, die es den Studierenden ermöglichen, sich in einfachen, routinemäßigen Situationen zurechtzufinden, z.B. auf Reisen, beim Arzt, auf Wohnungssuche, im Kaufhaus, unter Kollegen, Freunden und Nachbarn.
Sie lernen/üben grundlegendes Vokabular/Ausdrucksmöglichkeiten zu Themen wie Ausbildung, Beruf, Gesundheit und Reisen. Sie lernen/üben ein erweitertes Spektrum an Haupt- und Nebensätzen zu klassifizieren und zu benutzen (Finalsatz, Infinitivsatz, indirekte Frage, temporaler Nebensatz, Kausalsatz), im Präteritum, Perfekt und Plusquamperfekt zu berichten, den Gebrauch

des Komparativ und des Superlativ, die Deklination des Adjektivs (im Nominativ, Akkusativ und Dativ) und Sie wiederholen und erweitern den Gebrauch der Präpositionen im Akkusativ und Dativ. Es werden Strategien vermittelt, die mündlich wie schriftlich eine Verständigung trotz noch geringer Sprachkenntnisse ermöglichen. Außerdem werden Möglichkeiten aufgezeigt, den Lernprozess eigenverantwortlich effektiver zu gestalten und damit die eigene Lernfähigkeit zu verbessern. Die Studierenden üben Teamkompetenz durch kooperatives Handeln in multinational gemischten Gruppen.

Intended Learning Outcomes:
Das Modul orientiert sich am Niveau A2 des GER. Nach Abschluss dieses Moduls sind die Studierenden in der Lage im Gespräch einfache Sätze und Redewendungen zu einem erweiterten Spektrum an vertrauten Themen zu verstehen und gebrauchen. Dabei handelt es sich um grundlegende Informationen zu alltäglichen, oder studien- bzw. berufsrelevanten Themen unter Einbeziehung landeskundlicher Aspekte.
Sie können beispielsweise sich und andere Personen, persönliche Wohnsituation, Gesundheitszustand, Freizeitverhalten und berufliche Situation beschreiben. Sie können sich bei der Wohnungssuche und in wesentlichen Situationen im Urlaub oder auf Reisen verständigen und von daraus resultierenden Erfahrungen und Erlebnissen in einfacher Standardsprache berichten. Die Studierenden können längere Texte und Briefe zu vertrauten Themen verstehen, in denen gängige aber einfache alltags- oder berufsbezogene Sprache verwendet wird und in denen vorhersehbare Informationen zu finden sind. Sie sind in der Lage kurze, informative Texte oder Mitteilungen zu grundlegenden Situationen in Alltag und Studium zu verfassen.

Teaching and Learning Methods:
Die LV besteht aus einem Seminar, in dem die angestrebten Lerninhalte mit gezielten Hör-, Lese, Schreib- und Sprechübungen erarbeitet werden. Durch die Kombination dieser Übungen in Einzel-, Partner- und Gruppenarbeit wird der kommunikative und handlungsorientierte Ansatz umgesetzt. Durch kontrolliertes Selbstlernen grundlegender grammatischer Phänomene und Kommunikationsmuster in der Fremdsprache mit vorgegebenen (online-) Materialien werden die im Seminar vermittelten Grundlagen vertieft.
Freiwillige Hausaufgaben (zur Vor- und Nacharbeitung) festigen das Gelernte.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial, auch online

Reading List:
Lehrbuch: wird im Kurs bekannt gegeben

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache A2.1 plus A2.2 (Seminar, 6 SWS)
Hanke C, Reulein C, Zerfass A

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

Module Description

SZ0331: German for Engineers C1 | Deutsch für Ingenieur/innen C1

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	**Language:** German	**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 den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Die Prüfungsleistungen werden in Form von kompetenz- und handlungsorientierten (Portfolio-) Prüfungsaufgaben erbracht. Hilfsmittel sind erlaubt.
Die Prüfungsleistungen sind in ihrer Gesamtheit so konzipiert, dass die Anwendung von Wortschatz und Grammatik, das Lese- und/oder Hörverstehen sowie die freie Textproduktion geprüft werden.
Mündliche Kommunikationsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
Deutschkenntnisse Niveau C1/gesicherte Deutschkenntnisse der Stufe B2.2

Content:
Das Modul orientiert sich am Niveau C1 des GER. In diesem Modul werden Kenntnisse in Deutsch als Fremdsprache erarbeitet, die es den Studierenden ermöglichen, in Studium und Beruf flüssig über ingenieurwissenschaftliche Themen des eigenen und eines fremden Fach- und Interessengebiets zu kommunizieren. Die Studierenden erarbeiten einen umfangreichen und differenzierten Wortschatz zu einem breiten Spektrum an technischen Themen. Sie verwenden Strategien, die effizientes Hören und Lesen im Fach unterstützen, vertiefen ihre Kenntnisse zu relevanten Strukturen wie z.B. zum Nominalstil und erweitern ihr Repertoire an fachsprachlichen Diskursmustern (z.B. Ursachen und Wirkungen beschreiben, definieren etc.). Im Seminar präsentieren sie einen komplexen Gegenstand ihres Faches und diskutieren aktuelle Themen mit ingenieurwissenschaftlichem Bezug.

Intended Learning Outcomes:
Im Anschluss an das Modul können die Studierenden relevanten Fachwortschatz kompetent verwenden und dabei auch komplexe Satzstrukturen produzieren. Sie können authentischen Lese- und Hörtexten wichtige Informationen in der für Studium und Beruf erforderlichen Schnelligkeit entnehmen. Sie verfügen über sprachliche Mittel, die erfolgreiche Kommunikation über ingenieurwissenschaftliche Zusammenhänge in interkulturellen sowie interdisziplinären Teams ermöglichen. Die Studierenden sind in der Lage, zu kontroversen Themen mit ingenieurwissenschaftlichem Bezug ausführlich und logisch nachvollziehbar Stellung zu beziehen.

Teaching and Learning Methods:
Das Modul besteht aus einem Seminar, in dem die angestrebten Lerninhalte mit gezielten Hör-, Lese- und Sprechübungen in Einzel-, Partner- und Gruppenarbeit kommunikativ und handlungsorientiert erarbeitet werden. Eine fachbezogene Präsentation zu Studieninhalten im Rahmen der Lehrveranstaltung ist obligatorisch. Freiwillige Hausaufgaben (zur Vor- und Nacharbeitung) festigen das Gelernte.

Media:
multimedial gestütztes Lehr- und Lernmaterial, auch online

Reading List:
Lehrbuch: wird im Kurs bekannt gegeben

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch für Ingenieur/innen C1 (Seminar, 2 SWS)
Hartkopf D
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0332: German as a Foreign Language B2+C1 - Intercultural Communication Skills - "Working as an Engineer in Germany" | Deutsch als Fremdsprache B2+C1: Interkulturelle Kommunikation - Als IngenieurIn in Deutschland arbeiten

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** irregularly
Credits:* 1	**Total Hours:** 45	**Self-study Hours:** 30	**Contact Hours:** 15

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

Description of Examination Method:
1 schriftlicher Test 90 min. (100%), Hilfsmittel sind erlaubt.
In der schriftlichen Prüfung werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Dabei lösen die Kandidaten Aufgaben, die Faktenwissen zu Besonderheiten des deutschen Arbeitsmarktes und zu interkulturellen Modellen abfragen. Ferner wird die interkulturelle Reflexionskompetenz durch die schriftliche Analyse von Critical Incidents geprüft. 25% der Note besteht aus der Bewertung des sprachlichen Ausdrucks in der Fremdsprache Deutsch.

Repeat Examination:

(Recommended) Prerequisites:
gesicherte Deutschkenntnisse mindestens der Stufe B2.1

Content:
Das Modul orientiert sich am Niveau B2/C1 des GER. Im Seminar werden Kenntnisse in interkultureller Kommunikation erarbeitet, die es Studierenden in ingenieurwissenschaftlichen Fächern ermöglichen, interkulturell kompetent und zielführend in multinationalen Projektteams und im deutschen Arbeitskontext zu kommunizieren. Die Studierenden erarbeiten die Anwendung interkultureller Modelle zur Analyse komplexer, interkulturell anspruchsvoller Situationen im beruflichen Umfeld. Ferner erhalten Sie Faktenwissen über die Besonderheiten des deutschen Arbeitsmarktes, wie Sozialpartnerschaft, betriebliche Mitbestimmung, Inhalt und Aufbau eines Arbeitsvertrages, Unternehmensstrukturen, etc. Dazu erarbeiten sie sich den entsprechenden wirtschaftsdeutschen Fachwortschatz.

Intended Learning Outcomes:
Die Studierenden können erkennen, inwiefern und auf welche Weise die interkulturelle Komponente in der konkreten Zusammenarbeit in multikulturellen Teams eine Rolle spielt. Sie haben sich Tools zur Analyse und zielführenden Interpretation interkulturell komplexer Situationen erarbeitet und verfügt über die sprachlichen Mittel, diese kommunikativ umzusetzen, um eine gegenseitige Verständigung zu ermöglichen. Sie können nach Bedarf das eigene Wissen über abweichende kulturelle Werte und Standards durch gezieltes Nachfragen erweitern und die eigene Sichtweise darlegen. Sie können annähernd flüssig argumentieren und auf die Argumente anderer sowohl mündlich als auch schriftlich eingehen.

Teaching and Learning Methods:
Das Modul besteht aus einer Lehrveranstaltung, in der die angestrebten Lerninhalte anhand von Selbsterfahrungsübungen, Videomaterial, Critical Incidents und theoretischem Input in Einzel-, Partner- und Gruppenarbeit kommunikativ und handlungsorientiert erarbeitet werden. Freiwillige Hausaufgaben (zur Vor- und Nacharbeitung und zur Vertiefung des eigenen Hintergrundwissens) festigen das Gelernte.

Media:
multimedial gestütztes Lehr- und Lernmaterial, auch online

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache B2+C1 - Interkulturelle Kommunikation - "Als Ingenieur/in in Deutschland arbeiten" (Seminar, 2 SWS)
Koch H, Nierhoff-King B
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0335: German as a Foreign Language A1.2 + A2.1 | Deutsch als Fremdsprache A1.2 + A2.1

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** irregularly
Credits:* 8	**Total Hours:** 270	**Self-study Hours:** 180	**Contact Hours:** 90

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

Description of Examination Method:
In den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Die Prüfungsleistungen werden in Form von kompetenz- und handlungsorientierten (Portfolio-) Prüfungsaufgaben erbracht.
Hilfsmittel sind erlaubt.
Die Prüfungsleistungen sind in ihrer Gesamtheit so konzipiert, dass die Anwendung von Wortschatz und Grammatik, das Lese- und/oder Hörverstehen sowie die freie Textproduktion geprüft werden.
Mündliche Kommunikationsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
gesicherte Kenntnisse der Stufe A1.1; Einstufungstest mit Ergebnis A1.2

Content:
In diesem Modul werden Grundkenntnisse in Deutsch als Fremdsprache unter Berücksichtigung interkultureller und landeskundlicher Aspekte vermittelt, die es den Studierenden ermöglichen, sich in alltäglichen Grundsituationen - z.B. in Studium oder Beruf, beim Arzt, beim Einkauf, auf Reisen, unter Kolleg*innen und Freund*innen - trotz geringer Sprachkenntnisse zurechtzufinden.
Sie lernen/üben grundlegendes Vokabular/Ausdrucksmöglichkeiten zu Themen wie Ausbildung, Beruf, Gesundheit, Wohnen, Kleidung, Feiern und Reisen. Sie lernen/üben, einfach strukturierte Haupt- und Nebensätze (z.B. aber, denn, dass, weil, etc.) zu benutzen, im Präsens und Perfekt zu berichten, den Gebrauch der Modalverben, des Imperativ, der Präpositionen mit Dativ und

Akkusativ, den Gebrauch des Komparativ und Superlativ und die Deklination des Adjektivs. Es werden Möglichkeiten aufgezeigt, den Lernprozess in der Fremdsprache eigenverantwortlich und effektiv zu gestalten. Die Studierenden üben Teamkompetenz durch kooperatives Handeln in multinational gemischten Gruppen.

Intended Learning Outcomes:
Das Modul orientiert sich am Niveau A1 und A2 des GER.
Nach Abschluss dieses Moduls sind die Studierenden in der Lage im Gespräch einfache Sätze und Redewendungen zu einem erweiterten Spektrum an vertrauten Themen zu verstehen und gebrauchen. Dabei handelt es sich um grundlegende Informationen zu alltäglichen oder studien- bzw. berufsrelevanten Themen unter Einbeziehung landeskundlicher Aspekte.
Sie können beispielsweise sich und andere Personen, persönliche Wohnsituation, Gesundheitszustand, Freizeitverhalten und berufliche Situation im Präsens oder Perfekt beschreiben.
Die Studierenden können längere Texte und Briefe zu vertrauten Themen verstehen, in denen gängige aber einfache alltags- oder berufsbezogene Sprache verwendet wird und in denen vorhersehbare Informationen zu finden sind. Sie sind in der Lage kurze, informative Texte oder Mitteilungen zu grundlegenden Situationen in Alltag und Studium zu verfassen.

Teaching and Learning Methods:
Das Modul besteht aus einem Seminar, in dem die angestrebten Lerninhalte mit gezielten Hör-, Lese, Schreib- und Sprechübungen erarbeitet werden. Durch die Kombination dieser Übungen in Einzel-, Partner- und Gruppenarbeit wird der kommunikative und handlungsorientierte Ansatz umgesetzt. Durch kontrolliertes Selbstlernen grundlegender grammatischer Phänomene und Kommunikationsmuster in der Fremdsprache mit vorgegebenen (online-) Materialien werden die im Seminar vermittelten Grundlagen vertieft.
Freiwillige Hausaufgaben (zur Vor- und Nacharbeitung) festigen das Gelernte.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial, auch online

Reading List:
Lehrbuch: wird im Kurs bekannt gegeben

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache A1.2 plus A2.1 (Seminar, 6 SWS)
Bakker S
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0337: German as a Foreign Language A1.1 | Deutsch als Fremdsprache A1.1

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	**Language:** Language taught	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 4	**Total Hours:** 135	**Self-study Hours:** 90	**Contact Hours:** 45

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

Description of Examination Method:
Performance, testing the learning outcomes specified in the module description, is examined by a cumulative portfolio of competence and action-oriented tasks. Aids are permitted.
The examination performances are designed in their entirety to test the use of vocabulary and grammar, reading and/or listening comprehension, and free text production.
Oral communication skills will be tested via the use of appropriate idioms in written dialogue examples and/or in the form of an audio/video file. For this purpose, we observe the Basic Data Protection Regulation (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
none

Content:
This module teaches basic knowledge of German as a Foreign Language, taking into account intercultural and cultural aspects of the country, which will enable students to find their way around despite their limited knowledge of the language, e.g. when shopping, in restaurants, on public transport, etc.
They will learn/practice basic vocabulary on topics such as family, work, leisure and food, ask and answer simple personal/family questions, understand and use numbers, prices and times and report everyday activities in simple structured main sentences in the present tense, using verbs, nouns, personal pronouns, possessive articles and negation forms.
Students practice teamwork skills by collaborating on tasks in multinational groups.

Intended Learning Outcomes:
The module is oriented towards level A1 of the CEFR. After completing this module, students will be able to use everyday expressions and very simple sentences aimed at meeting specific needs of everyday life: They can introduce themselves and others and ask other people questions about themselves and give answers to questions of this kind. They can describe daily routines in basic structures and give basic information about themselves in writing. They can communicate their needs if interlocutors speak clearly and slowly and are supportive. Students learn how to organize their own learning process of the foreign language independently and effectively.

Teaching and Learning Methods:
The module consists of a seminar in which students study the learning content with targeted listening, reading, writing and speaking exercises. The communicative and action-oriented approach is implemented by combining these exercises in individual, partner and group exercises. Online material for controlled self-study of basic grammatical phenomena and communication patterns is provided to deepen and intensify the content taught during the course. Voluntary homework (for preparation and revision) consolidates what has been learned.

Media:
Textbook, multimedia-supported teaching and learning material, also online

Reading List:
Textbook: will be announced in the course

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache A1.1 (Seminar, 3 SWS)
Bakker S, Burmasova S, Detcheva-Knippelmeyer I, Grgic T, Gröbl J, Hanke C, Huber D, Jennert J, Keza I, Koch H, Kraut-Schindlbeck S, Lechle K, Pinskaia I, Pletschacher T, Schlüter J, Schmidt-Bender S, von Caprivi Caprara de Montecucculi A, von Egloffstein A

Blockkurs Deutsch als Fremdsprache A1.1 (Seminar, 3 SWS)
Comparato G, Kretschmann A, Lechle K, Schlüter J, von Egloffstein A, Zerfass A

Deutsch als Fremdsprache A1.1 - EuroTeq Programm (Seminar, 3 SWS)
Gröbl J
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0338: German as a Foreign Language A1.2 | Deutsch als Fremdsprache A1.2

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 4	**Total Hours:** 135	**Self-study Hours:** 90	**Contact Hours:** 45

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

Description of Examination Method:
In den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Die Prüfungsleistungen werden in Form von kompetenz- und handlungsorientierten (Portfolio-) Prüfungsaufgaben erbracht.
Hilfsmittel sind erlaubt.
Die Prüfungsleistungen sind in ihrer Gesamtheit so konzipiert, dass die Anwendung von Wortschatz und Grammatik, das Lese- und/oder Hörverstehen sowie die freie Textproduktion geprüft werden.
Mündliche Kommunikationsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
gesicherte Kenntnisse der Stufe A1.1; Einstufungstest mit Ergebnis A1.2

Content:
In diesem Modul werden Grundkenntnisse in Deutsch als Fremdsprache unter Berücksichtigung interkultureller und landeskundlicher Aspekte vermittelt, die es den Studierenden ermöglichen, sich trotz geringer Sprachkenntnisse z.B. beim Einkaufen, im Restaurant, im öffentlichen Verkehr etc. zurechtzufinden.
Sie lernen/üben grundlegendes Vokabular zu Themen wie Familie, Studium und Beruf, Freizeit, Wohnen, Gesundheit, Einkaufen und Reisen zu benutzen und in einfach strukturierten Hauptsätzen Alltägliches im Präsens und Perfekt zu berichten, unter Verwendung von

Modalverben, trennbaren Verben, Imperativ und grundlegender lokaler und temporaler Präpositionen.
Es werden Möglichkeiten aufgezeigt, den Lernprozess in der Fremdsprache eigenverantwortlich und effektiv zu gestalten. Die Studierenden üben Teamkompetenz durch kooperatives Handeln in multinational gemischten Gruppen.

Intended Learning Outcomes:
Das Modul orientiert sich am Niveau A1 des GER.
Nach Abschluss dieses Moduls sind die Studierenden in der Lage alltägliche Ausdrücke und einfache Sätze zu verwenden, die auf die Befriedigung konkreter, in der Bewältigung des Alltags wesentlicher Bedürfnisse zielen:
Sie können einfache Fragen in alltäglichen Situationen stellen und beantworten, Tagesabläufe in Vergangenheit und Gegenwart beschreiben und einfache schriftliche Mitteilungen zur Person machen, Verabredungen treffen und in grundlegenden alltäglichen Situationen beispielsweise beim Einkauf oder im Restaurant ihre Wünsche erfolgreich kommunizieren, wenn die Gesprächspartner langsam und deutlich sprechen und bereit sind zu helfen.

Teaching and Learning Methods:
Das Modul besteht aus einem Seminar, in dem die angestrebten Lerninhalte mit gezielten Hör-, Lese, Schreib- und Sprechübungen erarbeitet werden. Durch die Kombination dieser Übungen in Einzel-, Partner- und Gruppenarbeit wird der kommunikative und handlungsorientierte Ansatz umgesetzt. Durch kontrolliertes Selbstlernen grundlegender grammatischer Phänomene und Kommunikationsmuster in der Fremdsprache mit vorgegebenen (online-) Materialien werden die im Seminar vermittelten Grundlagen vertieft.
Freiwillige Hausaufgaben (zur Vor- und Nacharbeitung) festigen das Gelernte.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial, auch online

Reading List:
Lehrbuch: wird im Kurs bekannt gegeben

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache A1.2 (Seminar, 3 SWS)
Comparato G, Grgic T, Jennert J, Keza I, Khvintelani N, Menck-Zwick C, Meuschel G, Pinskaia I, Reulein C, Schlüter J, Thiessen E, von Egloffstein A

Blockkurs Deutsch als Fremdsprache A1.2 (Seminar, 3 SWS)
Kretschmann A, Lechle K, Menck-Zwick C, Meuschel G, Schlüter J, Stiebeler H, Stoephasius J, Winkler S
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0339: German as a Foreign Language B2.1 | Deutsch als Fremdsprache B2.1

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	**Language:** German	**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 den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Die Prüfungsleistungen werden in Form von kompetenz- und handlungsorientierten (Portfolio-) Prüfungsaufgaben erbracht.
Hilfsmittel sind erlaubt.
Die Prüfungsleistungen sind in ihrer Gesamtheit so konzipiert, dass die Anwendung von Wortschatz und Grammatik, das Lese- und/oder Hörverstehen sowie die freie Textproduktion geprüft werden.
Mündliche Kommunikationsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
gesicherte Kenntnisse der Stufe B1.2; Einstufungstest mit Ergebnis B2.1

Content:
Das Modul orientiert sich am Niveau B2 des GER. In diesem Modul werden Kenntnisse in Deutsch als Fremdsprache erarbeitet, die den Studierenden eine mündliche Diskurspartizipation zu aktuellen und wissenschaftlichen Themen ermöglicht. Die Studierenden behandeln Themen des Satzbaus und vertiefen ihre Kenntnisse zum Passiv sowie Strukturen, die für das Vergleichen relevant sind. Sie erweitern ihr Repertoire an Nomen, Verben und Präpositionen sowie an festen Verbindungen. Ein umfangreicher und differenzierter Wortschatz zu interkulturellen, sprachlichen und studienrelevanten Themen wird erarbeitet. Die Studierenden lernen den Gebrauch von

spezifischen Redemitteln für Meinungsäußerung, vergleichende Argumentation und persönliche Erfahrungsberichte.

Intended Learning Outcomes:
Im Anschluss an die Teilnahme an den Modulveranstaltungen können die Studierenden wesentliche Inhalte von authentischen Artikeln und Berichten aus dem eigenen Fach- und Interessensgebiet selbständig verstehen und wiedergeben. Sie sind in der Lage, in einer Diskussion oder Präsentation Standpunkte darzulegen, wobei sie komplexe Satzstrukturen und fachspezifisches Vokabular benutzen. Sie können begründen, warum sie einer bestimmten Meinung sind, und die Standpunkte anderer kommentieren.

Teaching and Learning Methods:
Das Modul besteht aus einem Seminar, in dem die angestrebten Lerninhalte mit gezielten Hör-, Lese-, Schreib- und Sprechübungen in Einzel-, Partner- und Gruppenarbeit kommunikativ und handlungsorientiert erarbeitet werden. Durch kontrolliertes Selbstlernen sollen von den Studierenden eigenständig Grammatikthemen und Wortschatzübungen mit vorgegebenen (Online-) Materialien erarbeitet werden. Freiwillige Hausaufgaben (zur Vor- und Nachbereitung der Lehrveranstaltung) festigen das Gelernte.

Media:
Lehrbuch, multimedial gestütztes Lehr- und Lernmaterial, auch online

Reading List:
Lehrbuch: wird im Kurs bekannt gegeben

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache B2.1 (Seminar, 2 SWS)
Comparato G, Huber D, Kraut-Schindlbeck S, Sabel B, Schlüter J, Stiebeler H, Thiessen E
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0340: German as a Foreign Language B2.2 | Deutsch als Fremdsprache B2.2

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	**Language:** German	**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 den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Die Prüfungsleistungen werden in Form von kompetenz- und handlungsorientierten (Portfolio-) Prüfungsaufgaben erbracht.
Hilfsmittel sind erlaubt.
Die Prüfungsleistungen sind in ihrer Gesamtheit so konzipiert, dass die Anwendung von Wortschatz und Grammatik, das Lese- und/oder Hörverstehen sowie die freie Textproduktion geprüft werden.
Mündliche Kommunikationsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
gesicherte Kenntnisse der Stufe B2.1; Einstufungstest mit Ergebnis B2.2

Content:
Das Modul orientiert sich am Niveau B2 des GER. In diesem Modul werden Kenntnisse in Deutsch als Fremdsprache erarbeitet, die es Studierenden ermöglichen, über allgemeine und berufsbezogene Themen aktiv und annähernd flüssig zu kommunizieren. Anhand von Lese- und Hörtexten zu verschiedenen Themen lernen die Studierenden, Inhalte mündlich und schriftlich kohärent zusammenzufassen und Vor- und Nachteile abzuwägen und Stellung zu nehmen. Die Studierenden erarbeiten sich ein Spektrum an themenbezogenem Vokabular, Redemitteln und Textbausteinen, die sie für das Zusammenfassen von Texten und den Austausch von Argumenten benötigen. Sie analysieren den Satzbau in komplexen Sätzen, setzen sich mit den entsprechenden

grammatischen Strukturen (wie z.B. Konnektoren, Kohäsionsmitteln und Partizipien) auseinander und vertiefen ihre Kenntnisse zur Wortbildung und den Nominalisierungsmöglichkeiten.

Intended Learning Outcomes:
Im Anschluss an die Teilnahme an den Modulveranstaltungen können die Studierenden den Inhalt von Texten zu allgemeinen und berufsbezogenen Themen verstehen und mündlich und schriftlich kohärent wiedergeben. Sie sind in der Lage, mündlich und schriftlich Argumente zu verschiedenen, mitunter auch kontrovers diskutierten Themen zu formulieren, gegeneinander abzuwägen und Stellung zu beziehen.

Teaching and Learning Methods:
Das Modul besteht aus einem Seminar, in dem die angestrebten Lerninhalte mit gezielten Hör-, Lese-, Schreib- und Sprechübungen in Einzel-, Partner- und Gruppenarbeit kommunikativ und handlungsorientiert erarbeitet werden. Durch kontrolliertes Selbstlernen sollen von den Studierenden eigenständig Grammatikthemen und Wortschatzübungen mit vorgegebenen (Online-) Materialien erarbeitet werden. Freiwillige Hausaufgaben (zur Vor- und Nacharbeitung der Lehrveranstaltung) festigen das Gelernte.

Media:
Lehrbuch, multimedial gestütztes Lehr- und Lernmaterial, auch online

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache B2.2 (Seminar, 2 SWS)
Hagner V, Huber D, Schmidt-Bender S, Selent D, Stoephasius J
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0346: German as a Foreign Language C1.2: Communicating Professionally in Science and Business | Deutsch als Fremdsprache C1.2 - Professionell kommunizieren in Wissenschaft und Beruf

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
In den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft.
Die Prüfungsleistungen werden in Form von kompetenz- und handlungsorientierten (Portfolio-) Prüfungsaufgaben erbracht.
Hilfsmittel sind erlaubt. Die Prüfungsleistungen sind in ihrer Gesamtheit so konzipiert, dass die Anwendung von Wortschatz und Grammatik, das Lese- und/oder Hörverstehen sowie die freie Textproduktion geprüft werden.
Mündliche Kommunikationsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
gesicherte Kenntnisse der Stufe C1.1; Einstufungstest mit Ergebnis C1.2

Content:
In diesem Modul werden Kenntnisse in Deutsch als Fremdsprache auf anspruchsvollem schriftsprachlichen Niveau und unter Berücksichtigung interkultureller, landeskundlicher und studienbezogener Aspekte erarbeitet.
Die Studierenden beschäftigen sich mit komplex aufgebauten und anspruchsvoll formulierten Hör- und Lesetexten auf wissenschaftssprachlichen Niveaus zu aktuellen Themen aus Bereichen wie z.B. Ökologie, Ökonomie und Soziologie. Sie überprüfen und vertiefen dabei ihre Fähigkeiten, mühelos und flüssig in der Fremdsprache zu agieren.

Sie erweitern ihre Fertigkeit, Textsorten und Schreibstile zu unterscheiden und implizit formulierte Meinungen zu identifizieren. Sie üben, komplexe Sachtexte auch außerhalb des eigenen Fachgebietes zu analysieren, strukturiert zu komprimieren und ausführlich Stellung zu beziehen. Sie üben, längeren Redebeiträgen, Vorträgen, Reportagen etc. detaillierte Informationen zu entnehmen. Sie lernen Bedeutungsnuancen verwandter Ausdrücke zu differenzieren und eine Vielzahl von Redewendungen zu verstehen. Sie vertiefen ein differenziertes Repertoire an Ausdrucksvarianten zu aktuellen Themen wissenschaftlicher und populärwissenschaftlicher Fragestellungen. Sie beschäftigen sich mit ausgewählten grammatischen Besonderheiten wie z.B. Nominalisierungsmöglichkeiten und Nominalstil, Textkohärenz, den verschiedenen Formen der Indirekten Rede, Wortbildungsvarianten und der Funktion des Pronomens „es“.
Die Studierenden hinterfragen Positionen des öffentlichen Diskurses auch nach ihrer kulturellen Bedingtheit. Sie setzten sich mit ausgewählten Aspekten der Arbeitskultur in Deutschland auseinander.

Intended Learning Outcomes:
Das Modul orientiert sich am Niveau C1 des GER.
Die Studierenden können den Inhalt von komplexen Artikeln und Berichten auch außerhalb des eigenen Fach- und Interessengebiets selbstständig und vielfach mühelos verstehen und Standpunkte identifizieren.
Sie können längeren Redebeiträgen und Vorträgen zu aktuellen Themen wie auch Fachvorträgen innerhalb und außerhalb ihres Fachgebietes folgen, sofern sie klar vorgetragen werden.
Sie sind in der Lage, zu aktuellen Themen aus Wissenschaft und Sozialleben ausführlich und logisch nachvollziehbar Stellung zu beziehen, sowie zu Themen aus ihrem Interessen- oder Fachgebiet klar strukturiert und verständlich zu referieren.

Teaching and Learning Methods:
Das Modul besteht aus einem Seminar, in dem die angestrebten Lerninhalte mit gezielten Hör-, Lese-, Schreib- und Sprechübungen in Einzel-, Partner- und Gruppenarbeit kommunikativ und handlungsorientiert erarbeitet werden. Ergänzend sollen die Teilnehmenden durch kontrolliertes Selbstlernen ausgewählte Grammatikthemen und Wortschatzübungen mit vorgegebenen Materialien eigenständig erarbeiten.
Freiwillige Hausaufgaben (zur Vor- und Nacharbeitung) festigen das Gelernte.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial, auch online

Reading List:
Lehrbuch wird im Seminar bekannt gegeben

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache C1.2 - Professionell kommunizieren in Wissenschaft und Beruf (Seminar, 2 SWS)
Koch H
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0348: German as a Foreign Language A1.1: Dive into the grammar and apply it in practice | Deutsch als Fremdsprache A1.1: Dive into the grammar and apply it in practice

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	**Language:** German	**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 den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Die Prüfungsleistungen werden in Form von kompetenz- und handlungsorientierten (Portfolio-) Prüfungsaufgaben erbracht. Hilfsmittel sind erlaubt.
Die Prüfungsleistungen sind in ihrer Gesamtheit so konzipiert, dass die Anwendung von Wortschatz und Grammatik, das Lese- und/oder Hörverstehen sowie die freie Textproduktion geprüft werden.
Mündliche Kommunikationsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
keine

Content:
In diesem Modul werden Grundkenntnisse in Deutsch als Fremdsprache vermittelt, die es den Studierenden ermöglichen, sich trotz geringer Sprachkenntnisse in alltäglichen Situationen zurechtzufinden.
Sie lernen grundlegende Strukturen der Wortbildung und des Satzbaus (Verben, Personalpronomen, Nomen, Präpositionen und Satzstrukturen), die es ermöglichen, Fragen und Antworten zu verstehen und zu formulieren und in einfach strukturierten Sätzen Informationen über sich und andere zu geben.

Es werden Möglichkeiten aufgezeigt grundlegendes Vokabular zu Themen wie Familie, Beruf, Freizeit und Essen eigenverantwortlich zu lernen sowie Zahlen, Preise und Uhrzeiten zu verstehen und zu benutzen. Auf der Basis der erworbenen Kenntnisse werden kommunikative Fertigkeiten in alltagstypischen Situationen angewendet.
Die Studierenden üben Teamkompetenz durch kooperatives Handeln in multinational gemischten Gruppen.

Intended Learning Outcomes:
Das Modul orientiert sich am Niveau A1 (GER). Nach Abschluss dieses Moduls sind die Studierenden in der Lage, Strukturen der Wortbildung und des Satzbaus zu verstehen und anzuwenden.
Sie können sich und andere vorstellen und anderen Leuten Fragen zu ihrer Person stellen und auf Fragen dieser Art Antwort geben, in einfacher Weise Tagesabläufe beschreiben und einfache schriftliche Mitteilungen zur Person machen. Sie können ihre Wünsche kommunizieren, wenn die Gesprächspartner deutlich und langsam sprechen und bereit sind zu helfen.

Teaching and Learning Methods:
Die LV besteht zum Teil aus Seminaren, zum Teil aus Tutorien. In den Seminaren werden Grammatik und Strukturen präsentiert und von den Studierenden in der Regel schriftlich angewendet. In den Tutorien werden erlernte Strukturen und Vokabular interaktiv eingeübt und in alltagstypischen Situationen angewendet und so die kommunikativen Fertigkeiten entwickelt. Materialien zur Anwendung der erlernten Inhalte werden auf Moodle bereitgestellt. Empfohlene Inhalte des begleitenden Lehrmaterials werden von den Studierenden im Selbststudium erlernt und vertieft. Freiwillige Hausaufgaben (zur Vor- und Nacharbeitung) festigen das Gelernte.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial, auch online

Reading List:
Lehrbuch: wird im Kurs bekannt gegeben

Responsible for Module:

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

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

Module Description

SZ0349: German as a Foreign Language C1 - Communication in Companies | Deutsch als Fremdsprache C1 - Kommunikation im Unternehmen

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
In den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft.
Die Prüfungsleistungen werden in Form von kompetenz- und handlungsorientierten (Portfolio-) Prüfungsaufgaben erbracht. Hilfsmittel sind erlaubt. Die Prüfungsleistungen sind in ihrer Gesamtheit so konzipiert, dass die Anwendung von Wortschatz und Grammatik, das Lese- und/oder Hörverstehen sowie die freie Textproduktion geprüft werden. Mündliche Kommunikationsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
Deutschkenntnisse Niveau C1/gesicherte Kenntnisse der Stufe B2.2

Content:
Das Modul orientiert sich am Niveau C1 des GER. In dieser Lehrveranstaltung werden Kenntnisse in Deutsch als Fremdsprache erarbeitet und vertieft, die den Studierenden ermöglichen, im beruflichen Kontext sprachlich souverän und flüssig zu kommunizieren. Anhand ausgewählter beruflicher Themenfelder (wie z. B. Karriereentwicklung, Unternehmensleitbilder, ‚Digitale Transformation‘, Kreativität und Innovation sowie Projektarbeit und Unternehmenspräsentation) werden Teilprozesse und Situationen aus dem Berufsalltag simuliert und aktiv trainiert, wie z.B. Leitbild eines Unternehmens verstehen, E-Mails kontextbezogen schreiben, Präsentationen halten und proaktiv an Meetings teilnehmen.

Die Studierenden vertiefen ein Spektrum an berufs- und branchenbezogenem Vokabular.
Sie trainieren entsprechende Mehrwortverbindungen und Dialogmuster und vertiefen ihre Grammatikkenntnisse in Bezug auf indirekte Aufforderungen (Imperativ, wichtige Verben mit Vorsilben) sowie den Verbal- und Nominalstil.

Intended Learning Outcomes:
Im Anschluss an das Modul kann der/die Studierende das Unternehmensleitbild eines Unternehmens verstehen und mögliche Fragen an das Unternehmen per E-Mail formulieren, einer Podiumsdiskussion die Hauptaussagen entnehmen und zusammenfassen, einen Kommentar per E-Mail verfassen, ein Produkt präsentieren und auf mögliche Fragen souverän reagieren.

Teaching and Learning Methods:
Das Modul besteht aus einem Seminar, in dem die angestrebten Lerninhalte mit gezielten Hör-, Lese- und Sprechübungen in Einzel-, Partner- und Gruppenarbeit kommunikativ und handlungsorientiert im jeweiligen Berufskontext erarbeitet werden.
Anhand ausgewählter Themenschwerpunkte und Kommunikationsmuster werden Grundlagen des monologischen und dialogischen Sprechens in der Fremdsprache zu beruflichen Themen vermittelt.
Freiwillige Hausaufgaben (zur Vor- und Nacharbeitung) festigen das Gelernte.

Media:
multimedial gestütztes Lehr- und Lernmaterial (Tafel, Folien, Übungsblätter, Bilder, Grafiken, Filme, etc.), auch online

Reading List:
Baier, Gabi/Karagiannakis, Evangelia/Merkelbach, Matthias/ Schappert, Petra/ Weimann, Gunther: Fokus Deutsch C1 – Erfolgreich im Alltag und Beruf, Berlin: Cornelsen 2022 (freiwillig)

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache C1 - Kommunikation im Unternehmen (Seminar, 2 SWS)
Häusler A
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0350: German as a Foreign Language B1.1 | Deutsch als Fremdsprache B1.1

Version of module description: Gültig ab winterterm 2022/23

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 4	**Total Hours:** 135	**Self-study Hours:** 90	**Contact Hours:** 45

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

Description of Examination Method:
In den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Die Prüfungsleistungen werden in Form von kompetenz- und handlungsorientierten (Portfolio-) Prüfungsaufgaben erbracht.
Hilfsmittel sind erlaubt.
Die Prüfungsleistungen sind in ihrer Gesamtheit so konzipiert, dass die Anwendung von Wortschatz und Grammatik, das Lese- und/oder Hörverstehen sowie die freie Textproduktion geprüft werden.
Mündliche Kommunikationsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
gesicherte Kenntnisse der Stufe A2.2; Einstufungstest mit Ergebnis B1.1

Content:
In diesem Modul werden Kenntnisse in Deutsch als Fremdsprache unter Berücksichtigung interkultureller, landeskundlicher und studienbezogener Aspekte erarbeitet, die es den Studierenden ermöglichen, sich in vertrauten Situationen, z.B. in Studium, Arbeit, Freizeit und Familie, und zu Themen von allgemeinem Interesse wie Konsum, Zukunft, Umwelt etc. selbständig und sicher in der Zielsprache zu verständigen, wenn Standardsprache verwendet wird.
Die Studierenden erweitern und benutzen ein grundlegendes Repertoire an logischen Haupt- und Nebensatz-Strukturen (z.B. Konsekutivsatz, Finalsatz und Relativsatz) und an Verben und Nomen mit Präpositionalergänzung. Sie lernen/üben den Genitiv, die Funktion und den Gebrauch des

Konjunktiv II und des Futur I. Sie wiederholen und ergänzen elementare Aspekte der Grammatik wie den Gebrauch der Zeiten und der Präpositionen.
Die Studierenden beschäftigen sich mit kulturspezifischen Besonderheiten, beispielsweise in Bezug auf Reiseverhalten, Berufswelt und Bewerbung sowie individuelle Zukunftskonzepte. Sie gewinnen Einblicke in aktuelle Themen wie Umwelt und Naturschutz.
Es werden Möglichkeiten aufgezeigt, den Lernprozess eigenverantwortlich effektiver zu gestalten und damit die eigene Lernfähigkeit zu verbessern.
Die Studierenden üben Teamkompetenz durch kooperatives Handeln in multinational gemischten Gruppen.

Intended Learning Outcomes:
Das Modul orientiert sich am Niveau B1 des GER.
Nach Abschluss des Moduls sind die Studierenden in der Lage sich in den meisten Situationen, denen man in Studium, Beruf und Freizeit im Sprachgebiet begegnet, sicher zu verständigen. Sie können über Vorlieben und Zukunftsvorstellungen sprechen, von Veränderungen berichten und Folgen ausdrücken, sich zur Berufswelt und Bewerbungen äußern sowie über umweltrelevante Themen diskutieren und eigene Ziele formulieren.
Sie können wesentliche Inhalte in einfachen, authentischen Texten aus alltäglichen Bereichen verstehen und wiedergeben und sich spontan an Gesprächen zu vertrauten Themen beteiligen.
Sie können längere persönliche E-Mails, Blog-Einträge und Texte zu eigenen Erfahrungen verfassen.

Teaching and Learning Methods:
Das Modul besteht aus einem Seminar, in dem die angestrebten Lerninhalte mit gezielten Hör-, Lese-, Schreib- und Sprechübungen erarbeitet werden. Durch die Kombination dieser Übungen in Einzel-, Partner- und Gruppenarbeit wird der kommunikative und handlungsorientierte Ansatz umgesetzt. Durch kontrolliertes Selbstlernen grammatischer Phänomene und Kommunikationsmuster in der Fremdsprache mit vorgegebenen (online-) Materialien werden die im Seminar vermittelten Grundlagen vertieft.
Freiwillige Hausaufgaben (zur Vor- und Nacharbeitung) festigen das Gelernte.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial, auch online

Reading List:
Lehrbuch: wird im Kurs bekannt gegeben

Responsible for Module:

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

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

Module Description

SZ0351: German as a Foreign Language B1.2 | Deutsch als Fremdsprache B1.2

Version of module description: Gültig ab winterterm 2022/23

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 4	**Total Hours:** 135	**Self-study Hours:** 90	**Contact Hours:** 45

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

Description of Examination Method:
In den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Die Prüfungsleistungen werden in Form von kompetenz- und handlungsorientierten (Portfolio-) Prüfungsaufgaben erbracht.
Hilfsmittel sind erlaubt.
Die Prüfungsleistungen sind in ihrer Gesamtheit so konzipiert, dass die Anwendung von Wortschatz und Grammatik, das Lese- und/oder Hörverstehen sowie die freie Textproduktion geprüft werden.
Mündliche Kommunikationsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
gesicherte Kenntnisse der Stufe B1.1; Einstufungstest mit Ergebnis B1.2

Content:
In diesem Modul werden Kenntnisse in Deutsch als Fremdsprache unter Berücksichtigung interkultureller, landeskundlicher, und studienbezogener Aspekte erarbeitet, die es den Studierenden ermöglichen, sich in vertrauten Situationen, z.B. in Studium, Arbeit, Freizeit und Familie, und zu Themen von allgemeinem Interesse wie Gesundheit, soziales Engagement, Kunst etc. selbständig und sicher in der Zielsprache zu verständigen, wenn Standardsprache verwendet wird.
Die Studierenden erarbeiten ein erweitertes Spektrum an Vokabular, Redewendungen und Dialogmustern, erfassen und benutzen ein grundlegendes Repertoire an logischen Haupt-

und Nebensatz-Strukturen (Temporalsatz, Relativsatz, Vergleichssatz) und an zweiteiligen Konnektoren. Sie lernen/üben den Gebrauch reflexiver Verben und das Passiv. Sie wiederholen und ergänzen elementare Aspekte der Grammatik wie den Gebrauch der Zeiten, der Präpositionen, der Deklination des Adjektivs und der Komparation.
Die Studierenden beschäftigen sich mit kulturspezifischen Besonderheiten, beispielsweise in Bezug auf Freundschaft und Beziehungen, Großstadtleben und soziale Projekte, und sie gewinnen Einblicke in die zeitgenössischen Kulturszene Deutschlands.
Es werden Möglichkeiten aufgezeigt, den Lernprozess eigenverantwortlich effektiver zu gestalten und damit die eigene Lernfähigkeit zu verbessern.
Die Studierenden üben Teamkompetenz durch kooperatives Handeln in multinational gemischten Gruppen.

Intended Learning Outcomes:
Das Modul orientiert sich am Niveau B1 des GER.
Nach Abschluss des Moduls sind die Studierenden in der Lage sich in den meisten Situationen, denen man in Studium oder Beruf, Freizeit und auf Reisen im Sprachgebiet begegnet, sicher zu verständigen. Sie können z.B. Informationen aus Zeitungstexten weitergeben, über lebenswerte Städte diskutieren, Personen und Dinge genauer beschreiben, Meinungen äußern und argumentieren.
Sie können wesentliche Inhalte in einfachen, authentischen Sachtexten, literarischen Texten und in Fernseh- oder Radiosendungen verstehen und wiedergeben und sich spontan an Gesprächen zu Themen von allgemeinem Interesse beteiligen. Sie können einfache formelle E-Mails und längere persönliche Briefe verfassen und von persönlichen Erfahrungen berichten. Sie können strukturiert zu einem alltäglichen Thema von persönlichem Interesse referieren und schriftlich eine logisch begründete Stellungnahme zu einem aktuellen Thema verfassen, wenn Hilfestellung gegeben wird.

Teaching and Learning Methods:
In diesem Modul werden Kenntnisse in Deutsch als Fremdsprache unter Berücksichtigung interkultureller, landeskundlicher, und studienbezogener Aspekte erarbeitet, die es den Studierenden ermöglichen, sich in vertrauten Situationen, z.B. in Studium, Arbeit, Freizeit und Familie, und zu Themen von allgemeinem Interesse wie Gesundheit, soziales Engagement, Kunst etc. selbständig und sicher in der Zielsprache zu verständigen, wenn Standardsprache verwendet wird.
Die Studierenden erarbeiten ein erweitertes Spektrum an Vokabular, Redewendungen und Dialogmustern, erfassen und benutzen ein grundlegendes Repertoire an logischen Haupt- und Nebensatz-Strukturen (Temporalsatz, Relativsatz, Vergleichssatz) und an zweiteiligen Konnektoren. Sie lernen/üben den Gebrauch reflexiver Verben und das Passiv. Sie wiederholen und ergänzen elementare Aspekte der Grammatik wie den Gebrauch der Zeiten, der Präpositionen, der Deklination des Adjektivs und der Komparation.
Die Studierenden beschäftigen sich mit kulturspezifischen Besonderheiten, beispielsweise in Bezug auf Freundschaft und Beziehungen, Großstadtleben und soziale Projekte, und sie gewinnen Einblicke in die zeitgenössischen Kulturszene Deutschlands.

Es werden Möglichkeiten aufgezeigt, den Lernprozess eigenverantwortlich effektiver zu gestalten und damit die eigene Lernfähigkeit zu verbessern.
Die Studierenden üben Teamkompetenz durch kooperatives Handeln in multinational gemischten Gruppen.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial, auch online

Reading List:
Lehrbuch: wird im Kurs bekannt gegeben

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Blockkurs Deutsch als Fremdsprache B1.2 (Seminar, 3 SWS)
Aristakesyan V, Schimmack B
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0356: German as a Foreign Language B2.1 - Start at Companies | Deutsch als Fremdsprache B2.1 - Einstieg ins Unternehmen

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:
In den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Die Prüfungsleistungen werden in Form von kompetenz- und handlungsorientierten (Portfolio-) Prüfungsaufgaben erbracht.
Hilfsmittel sind erlaubt.
Die Prüfungsleistungen sind in ihrer Gesamtheit so konzipiert, dass die Anwendung von Wortschatz und Grammatik, das Lese- und/oder Hörverstehen sowie die freie Textproduktion geprüft werden.
Mündliche Kommunikationsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
gesicherte Kenntnisse der Stufe B1.2; Einstufungstest mit Ergebnis B2.1

Content:
Das Modul orientiert sich am Niveau B2.1 des GER. In diesem Modul werden Kenntnisse in Deutsch als Fremdsprache erarbeitet, die es Studierenden ermöglichen, im beruflichen Kontext aktiv und annähernd flüssig zu kommunizieren.
Anhand verschiedener Themenfelder des Berufseinstiegs wie z.B. Stellensuche, Bewerbung und der erste Arbeitstag werden Situationen aus dem Arbeitsleben simuliert. Dazu gehört über die eigene Branche und Berufsziele sprechen, einen Lebenslauf schreiben, Telefonate führen, sich im Vorstellungsgespräch präsentieren, Small Talk, Einstand und Kennenlernen der Kolleg:innen.

Die Studierenden erarbeiten ein Spektrum an Vokabular für den Berufseinstieg, Redewendungen und Dialogmuster und benutzen Diskursmuster eines Vorstellungsgesprächs wie z.B. Selbstpräsentation, über Stärken und Schwächen sprechen, über Karriereziele sprechen.
Sie analysieren den Satzbau in komplexen Sätzen, setzen sich mit den entsprechenden Konnektoren auseinander und vertiefen Grammatikthemen wie z.B. den Gebrauch des Konjunktiv II für den höflichen Umgang im Gespräch oder Nominalisierungsstrategien für den Lebenslauf.
Die Studierenden üben Teamkompetenz durch kooperatives Handeln in multinational gemischten Gruppen.

Intended Learning Outcomes:
Im Anschluss an die Teilnahme an die Modulveranstaltungen können die Studierenden auf B2.1-Niveau auf formelle und informelle Kommunikationssituationen beim Berufseinstieg mündlich spontan und zusammenhängend und schriftlich angemessen und gut verstehbar reagieren.
Sie sind in der Lage, anhand realitätsnaher Szenarien eine Bewerbung zu schreiben, ein Telefonat mit einer Firma zu führen und bei Bedarf nachzufragen. Die Studierenden können sich im Vorstellungsgespräch präsentieren und auf Nachfragen angemessen reagieren. Sie unterscheiden formelle und informelle Redewendungen in E-Mails und können je nach Situation ihren Stil anpassen.
Sie können bezogen auf das eigene Fach annähernd flüssig sprechen und auf die Fragen anderer eingehen, sofern sie in der Standardsprache vorgetragen werden. In Konfliktsituationen können sie mit geeigneten Redemittel mitdiskutieren.

Teaching and Learning Methods:
Das Modul besteht aus einer Lehrveranstaltung, in der die angestrebten Lerninhalte mit gezielten Hör-, Lese- und Sprechübungen in Einzel-, Partner- und Gruppenarbeit kommunikativ und handlungsorientiert erarbeitet werden. Anhand vorgegebener Kriterien und Kommunikationsmuster werden Grundlagen des Referierens und des Diskutierens in der Fremdsprache zu beruflichen Themen vermittelt. Freiwillige Hausaufgaben (zur Vor- und Nacharbeitung) festigen das Gelernte.

Media:
Lehrbuch, multimedial gestütztes Lehr- und Lernmaterial, auch online

Reading List:
Lehrbuch: wird im Kurs bekannt gegeben

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache B2.1 - Einstieg ins Unternehmen (Seminar, 2 SWS)
Reulein C
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0359: German as a Foreign Language B2.2 - Start at Companies | Deutsch als Fremdsprache B2.2 - Einstieg ins Unternehmen

Version of module description: Gültig ab summerterm 2024

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

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

Description of Examination Method:
In den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Die Prüfungsleistungen werden in Form von kompetenz- und handlungsorientierten (Portfolio-) Prüfungsaufgaben erbracht.
Erlaubte Hilfsmittel werden jeweils definiert.
Die Prüfungsleistungen sind in ihrer Gesamtheit so konzipiert, dass die Anwendung von Wortschatz und Grammatik, das Lese- und/oder Hörverstehen sowie die freie Textproduktion geprüft werden.
Mündliche Kommunikationsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
Gesicherte Kenntnisse der Stufe B2.1; Einstufungstest mit Ergebnis B2.2

Content:
Das Modul orientiert sich am Niveau B2.2 des GER. In diesem Modul werden Kenntnisse in Deutsch als Fremdsprache erarbeitet, die es Studierenden ermöglichen, im beruflichen Kontext aktiv und flüssig zu kommunizieren.
Anhand verschiedener Themenfelder des Berufseinstiegs wie z.B. Stellensuche, Bewerbung und der erste Arbeitstag werden Situationen aus dem Arbeitsleben simuliert. Dazu gehört über die eigene Branche und Berufsziele sprechen, einen Lebenslauf schreiben, Telefonate führen, sich im Vorstellungsgespräch präsentieren, Small Talk, Einstand und Kennenlernen der Kolleginnen und Kollegen.

Die Studierenden erarbeiten ein Spektrum an Vokabular für den Berufseinstieg, Redewendungen und Dialogmuster und benutzen Diskursmuster eines Vorstellungsgesprächs wie z.B. Selbstpräsentation, über Stärken und Schwächen sprechen, über Karriereziele sprechen.
Sie analysieren den Satzbau in komplexen Sätzen, setzen sich mit den entsprechenden Konnektoren auseinander und vertiefen Grammatikthemen wie z.B. den Gebrauch des Konjunktiv II für den höflichen Umgang im Gespräch oder Nominalisierungsstrategien für den Lebenslauf.
Die Studierenden üben Teamkompetenz durch kooperatives Handeln in multinational gemischten Gruppen.

Intended Learning Outcomes:
Im Anschluss an die Teilnahme an die Modulveranstaltungen können die Studierenden auf B2.2-Niveau auf formelle und informelle Kommunikationssituationen beim Berufseinstieg mündlich spontan und zusammenhängend und schriftlich angemessen und gut verstehbar reagieren.
Sie sind in der Lage, anhand realitätsnaher Szenarien eine Bewerbung zu schreiben, ein Telefonat mit einer Firma zu führen und situationsgerecht zu interagieren. Die Studierenden können sich im Vorstellungsgespräch in einer Firma ausführlich und strukturiert präsentieren und auf Nachfragen angemessen reagieren. Sie unterscheiden formelle und informelle Redewendungen in E-Mails und können je nach Situation ihren Stil anpassen.
Sie können bezogen auf das eigene Fach flüssig sprechen und auf die Fragen anderer eingehen, sofern sie in der Standardsprache vorgetragen werden. In Konfliktsituationen können sie mit geeigneten Redemittel mitdiskutieren.

Teaching and Learning Methods:
Das Modul besteht aus einer Lehrveranstaltung, in der die angestrebten Lerninhalte mit gezielten Hör-, Lese- und Sprechübungen in Einzel-, Partner- und Gruppenarbeit kommunikativ und handlungsorientiert erarbeitet werden. Anhand vorgegebener Kriterien und Kommunikationsmuster werden Grundlagen des Referierens und des Diskutierens in der Fremdsprache zu beruflichen Themen vermittelt. Freiwillige Hausaufgaben (zur Vor- und Nacharbeitung) festigen das Gelernte.

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Deutsch als Fremdsprache B2.1 - Einstieg ins Unternehmen (Seminar, 2 SWS)
Reulein C
For further information in this module, please click campus.tum.de or here.

Module Description

SZ04104: English - English for Nerds: Learning with Sci-fi and Fantasy C1 | Englisch - English for Nerds: Learning with Sci-fi and Fantasy C1

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

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

Englisch - English for Nerds: Learning with Sci-fi and Fantasy C1 (Seminar, 2 SWS)
Clark R

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

Module Description

SZ04105: English - English Grammar Advanced C1 | Englisch - English Grammar Advanced C1

Version of module description: Gültig ab summerterm 2023

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

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Englisch - English Grammar Advanced C1 (Seminar, 2 SWS)
Clark R
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0426: English - Professional English for Business and Technology - Marketing Module C1 | Englisch - Professional English for Business and Technology - Marketing Module C1

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
Performance, testing the learning outcomes specified in the module description, is examined by a cumulative portfolio of competence and action-oriented tasks which include:
- 2 assignments for a total of 50%
- presentation on a current business related topic (including visual aids) 25%
- final written examination 25% based on topics and materials discussed in class.

As the course may be offered in various formats (online or classroom) the form and conditions of the final exam (with or without aids) will vary. Where audio or video is recorded, we observe the Basic Data Protection Regulation (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
Ability to begin work at the C1 level of the GER as evidenced by a score in the range of 60 – 80 percent on the placement test at www.moodle.tum.de. (Please check current announcements as the exact percentages may vary each semester.)

Content:
This course focuses on professional communication skills and integrates reading, listening, speaking and writing with vocabulary and grammar, as needed by the specific group. The subject matter consists of a wide range of current issues in the business world, ranging from ethics and sustainability to leadership and diversity. Students will have many opportunities to explore, critically discuss, present, and write about these topics and other business- and industry-relevant topics that are most interesting to them.

Intended Learning Outcomes:
After completion of this module, students will be able to understand complex texts on current business-related topics, critically analyse these and effectively communicate their ideas based on these in English to an international audience.

Students will develop an awareness of Anglo-American public speaking conventions and will be able to put these into practice. In written and spoken contexts they will be able to differentiate accurately between situations requiring formal or familiar registers and select the correct form. Further, the will impove their ability to present content clearly and succinctly taking readers' needs and writing conventions into consideration.

Corresponds to C1 of the CER.

Teaching and Learning Methods:
Communicative and skills-oriented approach to topics with use of group discussion, reading and listening exercises, pair and group tasks, presentations etc. Students will need to complete regular assignments.

Media:
Textbook, use of www.moodle.tum.de, online learning resources, presentations, film viewings and audio practice.

Reading List:
Handouts and selected extracts from published sources will be used in the course. Key literature will be advised by the teacher and/ or listed in the course description.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Englisch - Professional English for Business and Technology - Marketing Module C1 (Seminar, 2 SWS)
Lemaire E
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0453: English - Scientific Presentation and Writing C2 | Englisch - Scientific Presentation and Writing C2

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
Performance, testing the learning outcomes specified in the module description, is examined by a cumulative portfolio of competence and action-oriented tasks. An oral presentation including a handout and visual aids (25%), written assignments (50%), and a final exam (25%) contribute to the final course grade. Students are expected to complete a presentation, an argumentative research essay, five forum entries, and a final exam for the final grade.

As the course may be offered in various formats (online or classroom) the form and conditions of the final exam (with or without aids) will vary. Where audio or video is recorded, we observe the Basic Data Protection Regulation (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
Ability to begin work at the C2 level as evidenced by a placement test score in the range of 80 – 100 percent. (Please check current announcements as the exact percentages may vary each semester.)

Content:
This course allows students to practice for formal speaking tasks in English such as a class presentation, dissertation defense or conference talk, and for completing formal written tasks such as a journal article, report, project proposal or a literature summary.

Intended Learning Outcomes:
After completion of this module students can understand with increased ease virtually everything heard or read; they can summarize information from different spoken and written sources,

reconstructing arguments and accounts in a coherent presentation, and they can express themselves spontaneously very fluently and precisely, differentiating finer shades of meaning even in more complex situations.

Corresponds to C2 of the CER.

Teaching and Learning Methods:
Techniques for evaluating one's own presenting and writing will be practiced, with opportunities to revise drafts. Oral and written peer evaluations will form a regular component of the class sessions including use of an online peer forum and online instructor feedback.

Media:
Course handouts, online platform

Reading List:
Handouts and selected extracts from published sources will be used in the course. Key literature will be advised by the teacher and/ or listed in the course description.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Englisch - Scientific Presentation and Writing C2 (Seminar, 2 SWS)
Field B, Hughes K
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0495: English - English Conversation Partners Program B1-C1+ | Englisch - English Conversation Partners Program B1-C1+

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	Language: English	Duration: one semester	Frequency: winter/summer semester
Credits:* 2	**Total Hours:** 60	**Self-study Hours:** 30	**Contact Hours:** 30

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

Description of Examination Method:
Performance, testing the learning outcomes specified in the module description, is examined by a cumulative portfolio of competence and action-oriented tasks. In this class where the emphasis is on seizing the opportunity for regular discourse in English, students are required to evidence their participation in group discussions through a conversation diary. In addition, a group task to be delivered in class is also required to pass the course.

Where audio or video is recorded, we observe the Basic Data Protection Regulation (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
Ability to begin work at the B1 (minimum) evel as evidenced by the placement test.

Content:
This course gives students opportunities to practice speaking tasks in an informal environment through weekly class meetings. In addition, students will be organised into smaller groups (typically campus based) which will meet privately on a weekly basis for more conversation on self-directed topics.

Intended Learning Outcomes:
After completion of this module, students will be able to speak with ease in a variety of social situations, especially on topics of special interest to them and will show only little hesitation and need to search for expressions or self-correct grammar. They will be able to express complex ideas by paraphrasing and may need to fill gaps by using a dictionary or asking for help. They

will be aware of cultural differences and be able to analyze features of their own culture they may previously have taken for granted.

Teaching and Learning Methods:
Communicative and skills oriented treatment of topics with use of small group discussion, listening exercises, and pair work encourage active use of language, as well as opportunities for feedback.

Media:
Materials shared via Moodle.

Reading List:
Materials shared via Moodle.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Englisch - English Conversation Partners Program B1 - C1+ (Seminar, 2 SWS)
Eden C, Wellershausen N

Blockkurs Englisch - English Conversation Partners Program B1 - C1+ (Seminar, 2 SWS)
Ritter J
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0602: Italian A1.1 | Italienisch A1.1

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	**Language:** Language taught	**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 den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Sie beinhalten Aufgaben zur Anwendung von Wortschatz und Grammatik, zu Lese- und Hörverstehen sowie zur freien Textproduktion. Hilfsmittel erlaubt. Mündliche Reaktionsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).)

Repeat Examination:

(Recommended) Prerequisites:
keine

Content:
In diesem Modul werden Grundkenntnisse in der Fremdsprache Italienisch vermittelt, die es den Studierenden ermöglichen, sich in alltäglichen Grundsituationen trotz geringer Sprachkenntnisse zurechtzufinden. Dabei werden interkulturelle und landeskundliche Aspekte berücksichtigt.

Die Studierenden werden in die italienische Phonetik eingeführt; sie lernen und üben den Grundwortschatz; sie lernen und üben einfache Fragen zur Person zu stellen und zu beantworten, Interessen auszudrücken, Wünsche zu nennen, über die eigenen Gewohnheiten kurz zu berichten und Formulare auszufüllen. Es werden dabei grammatische Themen wie z.B. Präsensformen regelmäßiger und einiger unregelmäßiger Verben, Personalpronomen, bestimmte, unbestimmte Artikel, Fragesätze, Angleichung der Adjektive behandelt.
Außerdem werden Möglichkeiten aufgezeigt, wie man den Lernprozess in der Fremdsprache Italienisch eigenverantwortlich und effektiv gestalten kann.

Intended Learning Outcomes:
Das Modul orientiert sich am Niveau A1 – Elementare Sprachverwendung des Gemeinsamen Europäischen Referenzrahmens für Sprachen.
Nach Abschluss des Moduls sind die Studierenden in der Lage, sich auf sehr einfache Art in der Fremdsprache Italienisch zu verständigen, wenn die Gesprächspartner langsam und deutlich sprechen und bereit sind zu helfen. Sie können einfache Ausdrücke und Sätze verwenden, die auf die Befriedigung konkreter Bedürfnisse des alltäglichen Bedarfs zielen wie z. B. sich und andere vorstellen, Auskünfte über sich selbst geben und Auskünfte über die anderen erfragen, Wünsche äußern, über Tagesablauf und Vorlieben sprechen bzw. schreiben.

Teaching and Learning Methods:
Kommunikatives und handlungsorientiertes Erarbeiten der Inhalte; gezielte Hör-, Lese-, Schreib- und Sprechübungen; Einzel-, Partner- und Gruppenarbeit; Förderung kooperativen Lernens; Kontrolliertes Revidieren einzelner Aspekte der Grammatik mit vorgegebenen (online-) Materialien. Freiwillige Hausaufgaben zur Vor- und Nachbereitung festigen das Gelernte.

Media:
Lehrwerk; multimedial gestütztes Lehr- und Lernmaterial.

Reading List:
Lehrwerk (wird im Unterricht bekannt gegeben)

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Italienisch A1.1 (Seminar, 2 SWS)
Alfieri L, Aquaro M, Bonomini F, Mainardi D, Taddia E, Togni M, Villadei M, Zangrilli D

Blockkurs Italienisch A1.1 (Seminar, 2 SWS)
Schmidt C
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0705: Japanese A1.1 | Japanisch A1.1

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	**Language:** Language taught	**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 den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Sie beinhaltet Aufgaben zur Anwendung von Schriftzeichen, Wortschatz und Grammatik, zu Lese- und Hörverstehen sowie zur freien Textproduktion und wird in Form von kompetenz- und handlungsorientierten (Portfolio-)Prüfungsaufgaben abgehalten. Hilfsmittel erlaubt. Mündliche Reaktionsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
Den Teilnehmern wird empfohlen, sich vor Kursbeginn mit der Hiragana-Silbenschrift vertraut zu machen. Hierfür werden Unterlagen im jeweiligen Moodle-Kurs bereitgestellt.

Content:
In dieser LV werden neben der Einübung des japanischen Schrift- und Lautsystems (v.a. Hiragana) Grundkenntnisse des Japanischen vermittelt, die es den Studierenden ermöglichen, sich in alltäglichen Grundsituationen trotz geringer Sprachkenntnisse zurechtzufinden. Dabei werden interkulturelle und landeskundliche Aspekte berücksichtigt. Um dieses Ziel zu erreichen, wird Kommunikation im Kontext folgender Situationen eingeübt: sich vorstellen; einkaufen gehen; Öffnungszeiten/Telefonnummer erfragen etc. Dazu werden u.a. folgende Themen der Grammatik behandelt: Nominalaussage und Partikeln, Demonstrativpronomen, Zahlen und Zeitangaben.
Die Studierenden lernen, mit dem grundlegenden Vokabular zu Themen wie Familie, Beruf, Freizeit und Wohnen einfach strukturierte Hauptsätze zu formulieren und Alltägliches zu berichten/erfragen.

Intended Learning Outcomes:
Nach Abschluss dieses Moduls sind die Studierenden in der Lage, vertraute, alltägliche Ausdrücke und sehr einfache Sätze zu verstehen und zu verwenden, die auf die Befriedigung konkreter, in der Bewältigung des Alltags wesentlicher Bedürfnisse zielen. Der/die Studierende kann sich und andere vorstellen und anderen Leuten Fragen zu ihrer Person stellen, bzw. Fragen dieser Art beantworten. Er/Sie kann die japanischen Silbenschriften Hiragana selbstständig lesen, schreiben und aussprechen.

Teaching and Learning Methods:
Kommunikatives und handlungsorientiertes Erarbeiten der Inhalte; gezielte Hör-, Lese-, Schreib- und Sprechübungen; Einzel-, Partner- und Gruppenarbeit; Förderung kooperativen Lernens. Freiwillige Hausaufgaben zur Vor- und Nachbearbeitung festigen das Gelernte.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial

Reading List:
Lehrbuch (wird in der Lehrveranstaltung bekanntgegeben)
Vom Kursleiter selbst angefertigte/zusammengestellte Arbeitsblätter und (online-)Materialien.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Japanisch A1.1 (Seminar, 2 SWS)
Bauer K, Gottschalk H, Miyayama-Sinz M, Murakami N, Stinner-Hasegawa Y

Blockkurs Japanisch A1.1 (Seminar, 2 SWS)
Gottschalk H, Murakami N
For further information in this module, please click campus.tum.de or here.

Module Description

SZ0719: Japanese A2.1 + A2.2 | Japanisch A2.1 + A2.2

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
In den Prüfungsleistungen werden die in der Modulbeschreibung angegebenen Lernergebnisse geprüft. Sie beinhaltet Aufgaben zur Anwendung von Schriftzeichen, Wortschatz und Grammatik, zu Lese- und Hörverstehen sowie zur freien Textproduktion und wird in Form von kompetenz- und handlungsorientierten (Portfolio-)Prüfungsaufgaben abgehalten. Hilfsmittel erlaubt. Mündliche Reaktionsfähigkeiten werden anhand der Anwendung entsprechender Redemittel in schriftlichen Dialogbeispielen überprüft und/oder in Form einer Audio-/Videodatei. Hierzu beachten wir die Datenschutzgrundverordnung (DSGVO, Art. 12 -21).

Repeat Examination:

(Recommended) Prerequisites:
Erfolgreiche Teilnahme an der Stufe A 1.4 oder vergleichbare Kenntnisse

Content:
In dieser LV werden die Grundkenntnisse des Japanischen erweitert, die es den Studierenden ermöglichen, sich in alltäglichen Situationen mit Basissprachkenntnissen zurechtzufinden.
Dabei werden interkulturelle und landeskundliche Aspekte berücksichtigt. Das Erlernen der Schriftzeichen (Kanji) ist ebenfalls grundlegend. Um dieses Ziel zu erreichen, wird Kommunikation im Kontext folgender Situationen eingeübt: einfache Meinungen äußern; Abläufe/Zustand erklären; mit Freunden/der Familie im „einfachen Stil“ (nicht im „höflichen Stil“) sprechen etc. Dazu werden u.a. folgende Themen der Grammatik behandelt: direkte u. indirekte Rede, Konditionalsätze, Potenzialverben und Verbenpaare (transitiv/intransitiv). Die Studierenden lernen, in einfach strukturierten Haupt- und Nebensätzen Alltägliches zu berichten/erfragen.

Intended Learning Outcomes:
Nach Abschluss dieses Moduls kann der/die Studierende im Gespräch einfache Sätze und Redewendungen zu einem erweiterten Spektrum an vertrauten Themen verstehen und gebrauchen. Dabei handelt es sich um grundlegende Informationen zu alltäglichen Themen unter Einbeziehung landeskundlicher Aspekte. Der/die Studierende ist in der Lage, Pläne, Wünsche und Hoffnungen zu äußern, Einladungen auszusprechen, anzunehmen oder abzulehnen. Außerdem kann er/sie neben den japanischen Silbenschriften Hiragana und Katakana ca. 180 für den Alltag relevante Kanji (chinesische Schriftzeichen) verstehen und verwenden.

Teaching and Learning Methods:
Kommunikatives und handlungsorientiertes Erarbeiten der Inhalte; Gezielte Hör-, Lese-, Schreib- und Sprechübungen; Einzel-, Partner- und Gruppenarbeit; Förderung kooperativen Lernens. Freiwillige Hausaufgaben (zur Vor- und Nachbearbeitung) festigen das Gelernte.

Media:
Lehrbuch; multimedial gestütztes Lehr- und Lernmaterial

Reading List:
Lehrbuch (wird in der Lehrveranstaltung bekanntgegeben)
Vom Kursleiter selbst angefertigte/zusammengestellte Arbeitsblätter, (online-) Materialien.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Japanisch A2.1 + A2.2 (Seminar, 4 SWS)
Bauer K
For further information in this module, please click campus.tum.de or here.

Module Description

SZ1102: EuroTeQ Intercultural Workshop – Intercultural competencies for working in multicultural teams | EuroTeQ Intercultural Workshop – Intercultural competencies for working in multicultural teams

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	**Language:** English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 1	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**

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

Description of Examination Method:
1 written test 90 min. (100%)

Performance, testing the learning outcomes specified in the module description, is examined by a written test. Aids are permitted. Candidates work on tasks that focus on intercultural theories, intercultural models and other content covered in class. As part of the exam, students must prove their intercultural reflection skills by

Repeat Examination:

(Recommended) Prerequisites:
The course is especially intended for students in engineering programs, but is generally open to all TUM students. In particular, students who will be studying at a EuroTeQ partner university in the coming academic year or those, who are from partner universities and are currently studying at TUM and/or are participating in the EuroTeQ program should feel addressed. Students should envision themselves working in a European engineering context.

Content:
The workshops take place on 3-4 days in the specified period. One Workshop on Fridays / Saturdays and one on Mondays / Thursdays.
In addition to their specialist knowledge, future engineers must coordinate cross-disciplinary work and communicate with other disciplines. Accordingly, in a European job market, intercultural competencies and communication skills are required to create successful collaboration. Intercultural agility, which is essential for studying and working in a multicultural environment, consists of a combination of knowledge about intercultural contexts and an ability to critically

analyze one's own thoughts and values from an intercultural perspective After the course, students can apply intercultural models and strategies based on these models for the practical management of complex, interculturally challenging situations in university and professional settings.

Intended Learning Outcomes:
Students can recognize how intercultural factors can play a role when working in multicultural teams and how our ways of thinking, values, attitudes and our personal background influence the way we interact with others. They have acquired tools for analyzing and interpreting interculturally complex situations in a goal-oriented manner and have discourse strategies to implement these in discussions in order to facilitate mutual understanding. Students can expand their own knowledge of divergent cultural values and standards by asking purposeful and appropriate questions and they can present their own perspective.

Teaching and Learning Methods:
The module consists of a course in which the learning content is studied in a communicative and action-oriented manner using self-experience exercises, video material, critical incidents and theoretical input in individual, partner and group work. Additional self-study material is provided (for preparation and follow-up work and for deepening one's own background knowledge) for consolidation and supplementation of the classroom sessions.

Media:
Multimedia-supported teaching and learning material, also online

Reading List:

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
The EuroTeQ Engineer: Cultural Agility for Studying and Working in Multicultural Settings (Workshop, 1 SWS)
Elekes R, Nierhoff-King B
For further information in this module, please click campus.tum.de or here.

Module Description

WI001180: Tech Challenge | Tech Challenge

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:**
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:
Overview of Final Deliverables

1. Functional Prototype (in hard- and/or software): 40% of grade
2. Final Demo (7 minutes incl. video): 30% of grade
3. Technical Project Description: 15% of grade
4. Read Deck (up to 10 slides max.): 15% of grade

Details of final deliverables below.

Final Deliverable 1: Functional Prototype

- Functional prototype in hard- and/or software
- Not a final product, but should showcase at least one key aspect of your product/service
- For software, use any framework, IDE, language etc. that works
- For hardware, use MakerSpace & prototype budget (up to 250€ per team, only redeemable with invoice!)

Final Deliverable 2a: Final Demo…

- You will have exactly 7 minutes, incl. your video of up to 2 minutes; and Q&A thereafter
- Your demo (incl. video) should include: Team, Customer Need, Value Proposition, Prototype, Competition, Differentiation, Future Roadmap (Note: content is same as the read deck)
- All team members must present
- Slides should not distract from the presenter (e.g. too much text, low contrast, …)

Final Deliverable 2b: …and Video

- Cannot be longer than 2 minutes max. (and should be at least 1 minute long)
- Can be real-life video, powerpoint slides, animations, cartoons or any other video format
- Should not be silent - audio can be spoken text, real world sound, music, …
- Should cover: Customer Need, Value Proposition (Prototype optional), Differentiation
- Think of it as a marketing or sales tool

Final Deliverable 3: Technical Project Description

- Description of all hardware components and software modules/frameworks used, as well as step-by-step instructions to re-create your prototype (e.g. see project descriptions at Hackster.io)
- Link to an online code repository (e.g. GitHub, GitLab, BitBucket) is mandatory

Final Deliverable 4: Read Deck

- Needs to be understandable as stand-alone with no further explanation (assume reader has not seen demo or video!)
- Use presentation format (i.e. slides); different than the presentation used in demo!
- Cannot be more than 10 slides max. (excl. appendix)
- Your read deck should include: Team, Customer Need, Value Proposition, Prototype, Competition, Differentiation, Future Roadmap (note: content is same as final pitch)

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Knowledge: Willingness to participate; affinity with tech and entrepreneurship trends preferred
Abilities: Identifying opportunities; proactiveness; communication; teamwork; commitment
Skills: openness; analytical thinking; design thinking; self-motivation; networking

Content:
- Kick-off: Introduction to challenges, resources, objectives. “Challenge fair” at the end. Students are sensitized, inspired and stimulated to develop feasible, viable and holistic solutions to address current industrial topics as smart city, mobility, digital healthcare, Industry 4.0 and smart grid by utilizing cutting-edge technologies as cloud, IoT, AI, AR/VR.
- Challenge workshops: 1 day is reserved for each corporate to hold an interactive workshop with the batch of students interested to know more about the respective challenge (known needs, available technologies, boundary conditions, etc.).
- Interdisciplinary teams and ideas registration as pertaining to a specific challenge (choice made by teams): Team, Vision, Project Plan
- Ideation workshop: Design thinking, empathic exploration, needfinding, concept generation, evaluation, and selection
- Work-in-progress: Prototyping, testing, generating feedback, iterating, creating new insights and elaborating use cases. On demand office hours and consulting sessions with experts for ideation, technology development, product design, and team development.

- Customer Value Proposition, Market and Positioning with respect to competition, Unique Selling Proposition, Business Model, Value Chain, Market Entry
- Business Plan, pitch training
- Pre-Demo Day Meetup: User Acceptance Testing with respective challenge owners. Teams present, respective corporate provides feedback.
- Feedback integration to finalize project results
- Demo Day: Teams showcase their final concepts by means of their prototypes, videos, posters, and short business plans

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

- identify latest technology trends related to topics such as smart city, mobility, digital healthcare, Industry 4.0 and smart grid
- understand opportunities and challenges in applying cutting-edge technology (e.g., cloud, IoT, AI, AR/VR) to address a specific industrial challenge
- conduct project-based interdisciplinary teamwork
- carry out an individualized learning process by utilizing referenced online resources as well as on demand expert coaching regarding team development, technology development and product design
- evaluate own ideas, prototypes and project findings with experts, users, and customers, and work closely with their feedback
- recognize and utilize contemporary web platforms for digital project creation and sharing
- operate in a high-tech prototyping workshop equipped with latest technology and devices
- create functional prototypes to demonstrate own proposed solution to a specific industrial challenge
- devise a showcase of own project results to a broad audience of peers, academics and practitioners
- create short business plans to effectively communicate business value of own project results

Thus, students get familiarized with the many facets of entrepreneurship. In doing that, they are enabled to see, realize, and experience the multiplicity in the everyday life of an entrepreneur, entrepreneurial personalities, as well as entrepreneurial skills and motivations.

Teaching and Learning Methods:
Innovatively addressing complex themes as smart city and Industry 4.0 often requires the use of cutting-edge technologies within an entrepreneurial process. Based on this premise and to get the students understand and apply such a process, the module deploys hands-on project-based learning and interdisciplinary teamwork.

Each semester several industrial challenges are spotlighted as proposed by the participating corporates, who provide access to their proprietary technologies, resources, experts and coaches specific to their respective challenge. An industrial challenge is formulated to be broad, with the potential of breeding many specific projects in return. Students are encouraged to propose which challenge to address in which way (i.e., project idea) and within which team.

Through interactive team exercises and a semester-long project, the students experience peer-learning while gaining practice in assessing and optimizing usage of their team resources. They are also provided with team coaching sessions, individual mentoring, tutorials as necessary (challenge-dependent), and hands-on courses to operate machines and devices (3D printer, laser cutter, waterjet cutter, sensors etc.) at the high-tech prototyping workshop (team- and challenge-dependent).

Media:
- Online access to slides, hand-outs, materials through dedicated e-Learning account
- Online discussion forum connecting students and involved experts
- Accounts on contemporary web platforms for digital project creation and sharing (e.g., hackster, kaggle, datacamp)

Reading List:
A maintained list of references to relevant online course materials (e.g., UnternehmerTUM MOOC videos, Coursera, Udacity, edX, Udemy) to support an individualized learning process suited to students' various levels of expertise

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

Courses (Type of course, Weekly hours per semester), Instructor:
Tech Challenge (WI001180, englisch) (Seminar, 4 SWS)
Marín Ventura Y
For further information in this module, please click campus.tum.de or here.

Master's Thesis with Masterkolloquium | Master's Thesis mit Masterkolloquium

Module Description

ED100001: Master’s Thesis - Information Technologies for the Built Environment | Master’s Thesis - Information Technologies for the Built Environment

Version of module description: Gültig ab winterterm 2022/23

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 30	**Total Hours:** 900	**Self-study Hours:** 900	**Contact Hours:** 0

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

Description of Examination Method:
The Master's Thesis is a scientific elaboration within a time period of six months. The students work on specific complex research questions in digital methods for the built environment and develop solutions of their own by applying the scientific background acquired during their studies. By means of a written thesis the students explain the chosen approach and demonstrate their ability to precisely analyze the proposed method and to put it into the scientific context. The students should verify that they are able to investigate in a self-contained manner a new scientific topic related to digital methods. This includes in detail, depending on the topic, the search and review of literature, topic-related methods and concepts, the development of theoretical concepts, methodologies, methods, to implement related algorithms, to apply them to specific problems, to analyze and to assess the results, and to develop and derive conclusions.
The written thesis is accompanied by a Master´s Thesis Colloquium of 30 min in total (presentation and discussion). In the oral presentation, the students shall verify that they are able to give a presentation on a self-contained investigated scientific subject in front of a larger audience in order to demonstrate the ability to communicate found solutions and scientific content in a clear way. In addition, students shall verify that they are able to discuss and defend their own work in front of a scientific audience.
Different forms of assessment (written and oral) are necessary, because different competencies are verified by this. The Master’s Thesis must be submitted in written form, by which mainly thematic and methodical competences as well as competencies to structure a written scientific document and to properly reference related work are verified. In contrast, the Master’s Thesis Colloquium must be held in oral form. Via the presentation and defense (interactive scientific discussions with the scientific audience), the overarching understanding of the thesis topic, self-

competencies and soft skills such as skills of presentation, didactics and rhetoric can be verified. The grade is determined by weighted mean of the Master's Thesis (80 %) and the Master's Thesis Colloquium (20 %).

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Required and elective modules of the first 3 semesters.

Content:
This module is offered by all chairs that are contributing to this master studies. They propose suitable topics from their subject area, mostly an aspect of one of their research projects. They support the students in the acquisition of the scientific skills to investigate broadly an aspect of a subject area and based on that to answer a problem in the corresponding area with the use of scientific methods.
Under guidance students familiarize themselves with an area in digital methods for the built environment. They obtain a problem in that area which is still quite general, i.e. not yet specified concretely. They have to investigate and evaluate different approaches to solve the problem, and then decide for one path which is then to be executed.

Intended Learning Outcomes:
After the elaboration of the master's thesis the graduates know how to…
- rapidly become acquainted with a specific and complex subject area in Digital Methods for the Built Environment;
- embed a scientific problem in a scientific and technical environment;
- identify all important aspects of those parts which are necessary for finding a solution;
- develop algorithms and methods for solving problem-specific tasks based on the scientific background acquired during their studies;
- analyse and to evaluate the results;
- present the relevance and context of the topic, the scientific questions, the methodologies employed
for their solution, the results and discussion in a professional, well-structured written report;
- properly reference related work;
- present their results to a scientific audience.

Teaching and Learning Methods:
Self-study, regular discussions with the supervisor.

Media:

-

Reading List:

To be researched independently according to the scope of work.

Responsible for Module:

Prof. André Borrmann

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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