TUM School of Engineering and Design
Technische Universität München

Module Catalog

M.Sc. Resource Efficient and Sustainable Building
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 246

Required Modules | Pflichtmodule

Skill Area - Sustainability in Architecture, Towns and Cities and the Landscape | Kompetenzfeld - Nachhaltigkeit in Architektur, Stadt und Landschaft

Module Description

BGU62046: Sustainable Architecture, Urban and Landscape Planning | Nachhaltige Architektur, Stadt- und Landschaftsplanung

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
The certificate of achievement for the module is a scientific paper with a total length of 14 pages, which should be uploaded via Moodle.

After each of the 4 lecture blocks, an essay of 2 pages is to be written. The goal of these 4 essays is to demonstrate an understanding of the key approaches to sustainable architecture, urban and landscape planning in the areas of urban wellbeing, buildings, materials & resources, green/ blue/grey infrastructure, and operations & processes. By critically examining the contributions of the various aspects to urban sustainability, students demonstrate that they are able to compare the aspects and evaluate their impact on human life in the city as well as the planet's resources. The scope for this part of the scientific paper is individual work, is 8 pages and 30% goes into the overall assessment.

In the seminar, a concrete city is considered as a case study in the context of a worldwide comparison of cities. The contents taught in the lecture are to be applied and analyzed in the seminar, taking into account various criteria such as urban planning, green and open space planning, mobility, energy, water and waste. Finally, a vision of the corresponding city is to be developed from the result of the analysis. The scope for this part of the scientific elaboration is group work, amounts to 6 pages and goes to 70% into the overall assessment.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Empfohlen wird die erfolgreiche Teilnahme am Modul BV620007 - Grundlagen des nachhaltigen Bauens

Content:
Das Modul besteht aus einer Ringvorlesung und einem auf die Vorlesungsinhalte ausgerichteten Seminar. In dem Modul werden die wesentlichen Ansätze nachhaltiger Architektur, Stadt- und Landschaftsplanung vorgestellt sowie die Schnittstellen und Wechselwirkungen der Themenbereiche innerhalb des Gesamtsystems analysiert und bewertet.
In der Vorlesung vermitteln Fachexperten die Grundlagen der Planung zu den Bereichen Landschaftsarchitektur/öffentlicher Raum,
Wechselwirkungen von Raum- und Verkehrsplanung, Nachhaltiger Städtebau, Erreichbarkeit als Grundlage zur
Gestaltung nachhaltiger Mobilität, Elektromobilität, Regenerative Energiesysteme/ Energiewirtschaft,
Bauphysik/Energieeffizientes Bauen, Energieverwendung, Ressourcenschonendes Bauen, Baustoffe und Material,
Bautechnik und Life Cycle Engineering, Behaglichkeit und Lastmanagement, Immobilienentwicklung und
Wertermittlung sowie Digitale Werkzeuge der frühen Entwurfsplanung.
Im Seminar werden die einzelnen Themenbereiche aufgegriffen und vertieft untersucht. Es werden Zusammenhänge zwischen stadtplanerischen, architektonischen und fachspezifischen Konzepten vermittelt und die damit in Verbindung stehenden Energie-, Stoff- und Verkehrsströme aufgezeigt. Ausgehend von der kulturhistorischen
Einordnung und der geschichtlichen Entwicklung der Nachhaltigkeit werden Lösungsansätze zur Berücksichtigung ingenieurtechnischer Gesichtspunkte im Hinblick auf ein nachhaltiges Planen und Handeln untersucht und entwickelt. Dies erfolgt anhand von Beispielen themenbezogen, teilweise auch selbstständig. Es wird ein Überblick über das systemische Zusammenwirken der einzelnen Planungskomponenten erarbeitet, auf dessen Grundlage die Auswirkungen von Entscheidungen der einzelnen Planungsbeteiligten auf das Gesamtsystem der Planung verdeutlicht werden.

Intended Learning Outcomes:
Nach dem Besuch des Moduls sind die Studierenden in der Lage
- allgemeine Nachhaltigkeitskriterien in Architektur, Stadt- und Landschaftsplanung im Bestand und Neubau von Gebäuden und Gebäudegruppen und den dazu gehörigen Systemen in den Bereichen Material, Gebäudekonzepte, Energieversorgung und Integration erneuerbarer Energien sowie im Städtebau, der Raumplanung und in Erreichbarkeit und Mobilität zu verstehen
- die Zusammenhänge des Verbrauchs von Ressourcen (Energie, Material, Wasser) zu verstehen
- Fragen des Energie- und Ressourceneinsatzes im Gebäudebereich im Hinblick auf das Potenzial einer nachhaltigen

Planung zu analysieren
- die Zusammenhänge und das systemische Zusammenwirken der einzelnen Planungskomponenten zur Erzielung
nachhaltiger Planungsansätze zu bewerten
- selbstständig aktuelle politische und ordnungsrechtliche Rahmenbedingungen und die enthaltenen Fragestellungen
anhand der charakterisierten Systemwirkung zu analysieren
- die Auswirkungen von Planungsentscheidungen auf das Gesamtsystem zu bewerten
- selbstständig aktuelle Fragestellungen kritisch zu hinterfragen und angemessene Strategien und Lösungsansätze
zu entwickeln.
- gelernte Themenkomplexe komprimiert widerzugeben sowie die Präsentationen zu halten.

Teaching and Learning Methods:
Die Vermittlung der Lehrinhalte der Vorlesung erfolgt durch Vorträge von Fachexperten. Zur Vertiefung der Inhalte der
Fachvorträge liefern innerhalb des Seminars kurze Input-Vorträge durch die Studierenden eine Zusammenfassung der wesentlichen
Aussagen der Fachexperten und stellen den Fachvortrag in den Kontext des Bauens. Basierend darauf und auf
ergänzenden Vorträgen werden Diskussionen zu Fragestellungen der nachhaltigen Planung in den verschiedenen
Bereichen geführt, um den Lehrstoff zu analysieren und Lösungsansätze zu entwickeln. Ferner werden in
Gruppenarbeit ergänzende Inhalte und Berechnungsmethoden erarbeitet und vorgestellt. In der gruppenweisen Erarbeitung können die Lehrinhalte bereits bei der Zusammenfassung diskutiert werden, so dass eine
tiefere Auseinandersetzung mit dem Thema erreicht wird. Die Vorstellung vor der gesamten Seminargruppe fördert
die Kompetenzen zur komprimierten Widergabe sowie die Präsentationskompetenzen der Studierenden.

Media:
Folien, Beamerpräsentation, Literatur, Computerberechnungen

Reading List:
Bott, H., Grassl, G.C., & Anders, S. (2014). Nachhaltige Stadtplanung: Konzepte für nachhaltige Quartiere. [München]: Detail.
Ekardt, F. (2016). Theorie der Nachhaltigkeit: Ethische, rechtliche, politische und transformative Zugänge - am
Beispiel von Klimawandel, Ressourcenknappheit und Welthandel (2., vollständig überarbeitete und aktualisierte
Auflage). Baden-Baden: Nomos.

Friedman, T. L. (2009). Hot, flat, and crowded: Why we need a green revolution--and how it can renew America
(Release 2.0, updated and expanded ; 1st Picador ed.). New York: Picador/Farrar, Straus and Giroux.
Heck, H.-D., & Meadows, D. L. (1972). Dennis Meadows [u.a.] Die Grenzen des Wachstums (The limits to growth,
dt.).
McDonough, W., & Braungart, M. (2002). Cradle to cradle: Remaking the way we make things (First edition). New
York: North Point Press.
Meadows, D. H., Meadows, D. L., & Randers, J. (1992). [Hauptband] (6. Aufl.). Die neuen Grenzen des Wachstums :
die Lage der Menschheit: Bedrohung und Zukunftschancen / Donella H. Meadows: A. Stuttgart: Dt. Verl.-Anst.

Responsible for Module:
Prof. Dr.-Ing. Werner Lang sekretariat.enpb.bgu@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Nachhaltige Architektur, Stadt- und Landschaftsplanung - Vorlesung (Vorlesung, 2 SWS)
Lang W [L], Hernández Chamorro A, Lang W, Schwering K, Staudt J

Nachhaltige Architektur, Stadt- und Landschaftsplanung - Seminar (Seminar, 2 SWS)
Lang W [L], Schwering K
For further information in this module, please click campus.tum.de or here.

Skill Area - Building Services Engineering and Renewable Energies | Kompetenzfeld - Gebäudetechnik und Erneuerbare Energien

Module Description

AR30327: Climate Responsive Building | Klimagerechtes Bauen

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German/English	**Duration:** two semesters	**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:
At the end of the module the proof of performance will be an written examination. In the examination 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.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
- Climate and climatic parameters
- Fundamentals of energy and renewable energy
- Thermal, 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)
- Winter and summer insulation
- Energy balance of the building in heating and cooling mode
- Room conditioning: heating, cooling, ventilation
- Technical building installation
- Daylight usage and sun protection, energy-efficient artificial lighting systems

- 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 mandatory 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:
In the weekly lectures the content of the module is mediated in form of lecture and presentation. The practical relevance is established by current projects and students' discussion.

Media:
PowerPoint presentation, script, blackboard

Reading List:
At the beginning of the semester a current bibliography of the semester subjects will be available at the chair

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, Vohlidka P

Klimagerechtes Bauen I (Vorlesung, 2 SWS)
Auer T, Vohlidka P, Wagner T, Zettelmeier C
For further information in this module, please click campus.tum.de or here.

Skill Area - Building Physics and Energy Efficiency | Kompetenzfeld - Bauphysik und Energieeffizienz

Module Description

BV360012: Energy-efficient Building | Energieeffizientes Bauen

Version of module description: Gültig ab winterterm 2018/19

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:
Exam duration (in min.): 90.
Proof of performance is provided in the form of a 90-minute written examination. The aim of the written test is to demonstrate that structural and HVAC concepts essential for energy-efficient construction have been understood at building level and can be reproduced and applied in compressed form. In a limited time and only with the help of a simple calculator problems must be recognized and solution must be found. The examination questions cover the entire content of the lectures. The answers require own formulations, marking multiple choice answers, or own calculations. No media are allowed except for a simple calculator.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Building Physics Basic Module
Building Physics - Supplementary Module

Content:
Energy in a national and international context, planning principles for energy-efficient construction, atriums, low-energy houses, passive houses, solar construction, detailed construction solutions, thermal insulation materials and systems in comparison, exterior - interior and roof insulation taking into account moisture, sound and summer heat insulation, principles of standards for energy-efficient construction including calculation methods for the energetic evaluation of residential and non-residential buildings.
Principles of dynamic thermal-hygric behaviour of buildings with

- Heating-up / cooling-down processes
- thermal storage
- Summer and winter heat behaviour
- Thermal component activation
- night-time ventilation
- soil channels
- Passive use of solar energy
- glass constructions
- Green solar architecture, low-energy house, passive house
- Glass double facades

Intended Learning Outcomes:
After participation the students will be able to understand and apply regulations and standards necessary for energy-efficient buildings as well as corresponding structural and technical principles of their implementation. In addition, they will be able to independently develop adequate solutions for building physics issues for energy-efficient construction.
Furthermore, the students will understand the basics of transient thermal and hygric behaviour of buildings and to evaluate thermal systems for energy efficiency of buildings.

Teaching and Learning Methods:
lectures, exercises and eLearning

Media:
Board, powerpoint presentations, eTeaching

Reading List:
- Bansal, N.K.; Hauser, G. und Minke, G.: Passiv Building Design. A Handbook of Natural Climatic Control. Elsevier Science B. V., Amsterdam, London, New York, Tokyo
(1994).
- Feist, W.: Grundlagen von Passivhäusern. Verlag das Beispiel. Darmstadt (1996).
- Hegger et al: Energie Atlas, Nachhaltige Architektur. Verlag Detail. München (2007).
- Pistohl, W.: Handbuch über Gebäudetechnik, Planungsgrundlagen und Beispiele. Band 2. Werner-Verlag, Düsseldorf (1996).
- Hauser, G. und Gertis, K.: Der sommerliche Wärmeschutz von Gebäuden (Normungsvorschlag). In: KI 8 (1980), H. 2, S 71-82.

Responsible for Module:
Klaus Sedlbauer (sekretariat.bp.bgu@tum.de)

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

Skill Area - Constructional Engineering and Lifecycle Engineering. | Kompetenzfeld - Bautechnik und Life Cycle Engineering

Module Description

BGU51037: Life Cycle Engineering | Life Cycle Engineering

Version of module description: Gültig ab winterterm 2017/18

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

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

Description of Examination Method:
The course's performance assessment will be one written exams (120 minutes), which consists of calculations and general knowledge based questions.
The written exam will test the students' ability to reproduce precisely the essential elements of life cycle assessment in general and in the context of building constructions as well as transfer this knowledge to different setting in a limited amount of time. The integration of case studies tests their knowledge, understanding and the ability of identification and adaptation of basic principles under time pressure.
A calculator, the building code (MBO) or (BayBO) and the normative standards provided within the lecture are permitted means. By means of the calculation examples, it is assessed if students are able to proof the fire safety of building elements based on normative standards and tabulated values within a limited time. Within the knowledge based questions it is assed to which extend students are able to explain the basic relationships and processes within fire development and fire spread as well as the influence to occupants and building elements. In addition, the competences to apply normative fire protection requirements in the selection of building materials and the design of components will be assessed.
The exam consists of case studies, knowledge and comprehension questions and problems as well as of multiple-choice questions, calculations and open questions.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Baukonstruktion und Tragwerkslehre 1,
Baukonstruktion und Tragwerkslehre 2,

Baukonstuktion III

Content:
The module ‘Life Cycle Engineering’ is composed of the two courses 'Principles in Building Construction' and ‘life cycle assessment’ which take place during winter semester.

The module ‘'Lifecycle Assessment’ takes place during winter semester. The essential content of the course is the Life Cycle Assessment Method and cross-linked thinking regarding environmental aspects, interdependencies and the interpretation of these.
The course 'Lifecycle Assessment’ gives an overview over the context of Life Cycle Assessment and different, alternative assessment methods. Therefore, the course illustrates general aspects and processes of a LCA as well as specific characteristic of LCA in the building sector. This distinction enables the students to draw nuanced conclusions to decisions and approaches of action. The international and national regulation form the basis of this seminary. The elemental knowledge to compile a LCA consists of:
- Goal and scope definition
- Lifecycle inventory analysis (LCI) and product systems
- Lifecycle impact assessment (LCIA), indicators and endpoint categories
- Interpretation, iteration and analysis
- Environmental product declaration and databases
- Allocation
- Substitution and End-of-Life aspects
- Recycling, use phase and lifetime of building components

The course includes the main topics of fire protection, divided into passive and active fire safety measures.
Within the passive fire protection the requirements of building authorities will be considered, which are mainly
influenced by the life safety and safety for loss of property.
This includes the building itself, neighboring property, requirements and design of building elements as well as means of escape. The teached active five protection measures include topics, such as equipment and strategies of fire departments.
The course finishes with the components of a customized fire protection concept regarding the safety goals of
building authorities. The single topics may be summarized as follows:
- basics of fire risk, fire spread, and fire exposure
- building materials
- building elements
- fire behavior of walls and floors
- regulations and building code
- part 1: classification, building development
- part 2: building elements
- part 3: means of egress
- part 4: building services

- fire measures of fire departments
- fire inspection
- fire protection concepts

Intended Learning Outcomes:
After participating in the module ‘Lifecycle Engineering’, students will be able to understand and apply the method of lifecycle assessment as well as to make use of the principal of cross-linked thinking regarding environmental aspects, interdependencies and the interpretation of these. This includes the basics of an environmental assessment, as well as the understanding and application of the functional principles considering the content, processes and methods of LCA. The can describe and understand the regulation background of LCA on an international and national basis. The participants will be able to design a goal and scope definition for the LCA of products and buildings and to develop and perform the calculation. The students can master the application and interpretation of datasets and databases (like oköbau.dat, ecoinvent etc.) quantitatively and understand the principle of operation of different LCA-tools (like eLCA, LEGEP, GaBi etc.). The will also be able to interpret the results appropriately.
After attending the course students are able to understand the essential relations within the fire development and fire spread as well as the influence of fire exposure to building elements and occupants, and to apply calculation methods and tabulated values in the design of building elements, like beams, walls and floors. Further, on the students learn how to define and evaluate the fire protection requirements for building materials and building elements as well as the overall fire safety of entire buildings based on the current building code.

Teaching and Learning Methods:
The module consists of lectures and practice sessions with blackboard and presentations. Additional practice sessions supplement the lectures by the application and calculation in MS Excel. The students can process case studies and systematic tasks for individual learning.
A workshop with focus on the application of this method, parallel to the lectures enables a deeper understanding and practical application of the theoretic elements of the lecture. The realistic context with a building as an example offers a direct approach to deal with datasets, databases and to gradually build implement and build up a lifecycle calculation within MS Excel. Lectures from partners with practical experience offer an outlook to the wide range of possibilities for application and integration of LCA.
The traditional lecture is illustrated by blackboard and PowerPoint-slides and additional videos for better understanding. The contents of the lecture will be deepened by an exercise session. This kind of lecturing allows an ideal and clear transmission of knowledge and interaction with the students as well as responding to student questions directly.

Media:
Presentations, blackboard presentations, script (lecture-slides) transcript.

Reading List:
Script and literature from the mandatory pre-requisite modules, personal transcript will be necessary

- Informationsportal Nachhaltiges Bauen: www.nachhaltigesbauen.de
- IPCC Reports
- Water Footprint Assessment Manual (2011)
- Ecological Footprint Atlas (2010)
- ILCD Handbook - General guide for LCA (2010)
- Humbert et al. (2012) - Impact 2002+ User Guide
- Rüter et al (2012) - Ökobilanz-Basisdaten für Bauprodukte aus Holz
- Klöpffer, W. (2014) - Ökobilanz (LCA)
- Kohler, König et al. (2010) - A life cycle approach to buildings
- Khouli, John et al (2015) - Sustainable Construction Techniques
- Guinée et al (2001), LCA - An operational guide to the ISO-standards
- Eyerer, P.: Ganzheitliche Bilanzierung, Werkzeug zum Planen und Wirtschaften in Kreisläufen; Springer Verlag; Heidelberg, Berlin, New York (1996).
- DIN EN ISO 14040:200911 Umweltmanagement Ökobilanz Grundsätze und Rahmenbedingungen
- DIN EN ISO 14044:200610 Umweltmanagement Ökobilanz Anforderungen und Anleitungen
- DIN EN 15804:2014-07: Nachhaltigkeit von Bauwerken - Umweltproduktdeklarationen - Grundregeln für die Produktkategorie Bauprodukte
- DIN EN 15978:2012-10: Nachhaltigkeit von Bauwerken - Bewertung der umweltbezogenen Qualität von Gebäuden – Berechnungsmethode
- MBO / BayBO
- National Standards, DIN 4102
- European Standards, DIN EN 1995-1-2
- Brandschutzatlas (FeuerTRUTZ GmbH)

Responsible for Module:
Stefan Winter (bauko@bv.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Ökobilanzierung (Vorlesung mit integrierten Übungen, 2 SWS)
Winter S [L], Hartmann M, Ott S, Wagner A, Ebert S

Grundlagen des Brandschutzes (RNB) (Vorlesung mit integrierten Übungen, 2 SWS)
Winter S [L], Merk M, Engel T
For further information in this module, please click campus.tum.de or here.

Elective Modules | Wahlmodule

Skill Area - Sustainability in Architecture, Towns and Cities and the Landscape | Kompetenzfeld - Nachhaltigkeit in Architektur, Stadt und Landschaft

Module Description

LS10006: Vertical Farming | Vertical Farming

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
The examination performance is given in the form of a project work. It consists of a written report (approx. 15 pages; 60% of the grade), supplemented by two oral group presentations ((i) 60 min., 20% of the grade; (ii) 15 min. + 10 min. discussion, 20% of the grade). In the final written paper, students present their design for a concept for a Vertical Farming Indoor System on the Weihenstephan campus. In it, the students also demonstrate that they can evaluate the aspects of Vertical Farming with regard to your concrete application in the experimental station (Lab) on site. In the presentation (PowerPoint and additional tools), students collectively present an (i) analysis on vertical farming systems, hydroponics, aquaponics and related technologies, and a (ii) strategy to explain the Vertical Farming system, demonstrate their communication skills as well as their presentation and discussion skills in front of an audience.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic knowledge in engineering, agriculture and computer sciences is an advantage.

Content:
The module will focus on Vertical Farming, which can contribute to the improvement of sustainable food production, resource management and energy conservation. The fundamentals of Vertical Farming production systems will be discussed and adapted to urban conditions. Concept

development and design of Vertical Farming-systems (hydroponics and aquaponics), electrical and artificial intelligence, plant and pest management are the core topics of the module. Students will learn methods and innovative approaches for vertical farming systems, and they will develop the concept for a Vertical Farming indoor system as part of the Sustainable Living Lab initiative. The highly automated system with integrated lighting will serve as a prototype and be able to produce food 365 days a year.
The module will consist of a project (PT) where students have to design a Vertical Farming-system.
The Module is intended to provide a framework for structured discussions around the topic of sustainability and sustainable food systems in urban areas and to offer practical opportunities for implementation. Sustainability will also be considered in the construction and energy supply. Interdisciplinary collaboration between different disciplines is crucial to the successful implementation of the concept.

Intended Learning Outcomes:
On successful completion of the module, participants are able to:
1. analyze the benefits and trade-offs of vertical farming systems and their role in sustainable food systems
2. understand the fundamentals of hydroponic and aquaponic systems;
3. create a concept for a Vertical Farming indoor system for the Sustainable Living Lab that integrates electrical engineering, artificial intelligence, and architecture on the Weihenstephan Campus;
4. develop a strategy for plant management and VF system management;
5. communicate their VF concept and design with understanding and evidence.

Teaching and Learning Methods:
The module will consist of a Project (PT) where students will design a Vertical Farming system. The Module is an interactive, hands-on, and interdisciplinary teaching format based on experimental learning with a strong emphasis on group work and discussion in a "flipped classroom design". In this respect, it is a project, as students will design their own concept. Guest lectures and basic information on vertical farming systems, pest management, hydroponics, urban agriculture challenges, and public health and awareness will further support students. In addition, students will have the opportunity to attend the Urban Agriculture course lecture series. Participants in groups will have access to the high-tech Makerspace workshop and a start-up budget to develop their own concept. Students from all faculties can participate in the module. The project is offered in English so that international students can also be integrated.

Media:
Presentations, scientific articles, group discussions, posters.

Reading List:
Not specified

Responsible for Module:
Egerer, Monika, Prof. Dr. monika.egerer@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Project Vertical Farming (Projekt, 4 SWS)
Egerer M [L], Egerer M
For further information in this module, please click campus.tum.de or here.

Module Description

AR20091: Supplementary Introduction to Urbanism | Ergänzende Einführung Städtebau

Version of module description: Gültig ab summerterm 2018

Module Level: Bachelor/Master	**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:
Die Modulprüfung wird in Form einer Übungsleistung und einer mündlichen Prüfung absolviert. Anhand kleiner urbanistischer Entwurfsaufgaben wird theoretisches städtebauliches Wissen auf seine Anwendung im konkreten Fall hin geprüft. Durch Transferleistung wird das Wissen in 2 Übungen zur analytischen Erfassung und Einordnung von Stadträumen, gesellschaftlichen Tendenzen und Referenzprojekten sowie Entwurfsstrategien angewandt. Bestandteile sind jeweils die Recherche vor Ort und die graphische Darstellung des thematisierten räumlichen Sachverhaltes. Ergänzend greift der Studierende ein Vorlesungsthema auf und erläutert dieses im abschließenden, mündlichen Prüfungsgespräch durch Anwendung auf einen Praxisfall. Dadurch wird die verbale Kommunikation städtebaulicher Sachverhalte in der Praxisanwendung abgeprüft.

Die Bewertungen der zwei zeichnerisch und schriftlichen Übungen und des Prüfungsgesprächs werden zusammengezogen und ergeben die Modulnote.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Das Modul AR20091 ist eine thematische Auskopplung aus dem Pflichtmodul AR 20016: Städtebau aus dem Bachelor-Studiengang Architektur und kann daher nicht von den (regulär für diesen Studiengang an der TUM
eingeschriebenen) Studierenden dieses Studiengangs belegt werden.

AR20091 – Ergänzende Einführung Städtebau richtet sich an Studierende welche im Rahmen eines anderen Studiengangs oder eines Gastaufenthaltes an der TU München grundlegende Kenntnisse zu städtebaulichen Transformationsprozessen und in Konzepten und Werkzeugen des Städtebaus erwerben möchten. Für Studierende, welche erst ab der Masterstufe mit einem

Wechsel des Studiengangs das Thema Stadt vertiefen möchten, eignet sich AR 20091 als guter Einstieg in die Grundkonzepte, Werkzeuge und Elemente des Städtebaus.

Content:
Das Modul AR 20091: Ergänzende Einführung Städtebau vermittelt ein Grundverständnis für die Komplexität und Vielfalt städtischer Räume in der Erläuterung von Grundkonzepten, Werkzeugen und Elementen des Städtebaus. Topographie und Kontext, Körper und Raum, Ort und Geschichte, Nutzung und Gebrauch, Routinen und Rituale, Zeiträume und Bewegung, subjektives Gefühl und kollektive Erinnerung, Infrastruktur und wirtschaftliche Dynamik sind nur einige von vielen Faktoren, die der Analyse zugänglich sind. Der Maßstab umfasst den engeren Kontext im städtebaulichen Umfeld bis hin zu regionalen Strukturen, von der Stadt und ihrem Umland bis hin zur Region. Das städtebauliche Instrumentarium der Architektur wird systematisch auf diversen städtebaulichen Maßstabsebenen und mit unterschiedlichen thematischen Schwerpunktsetzungen angewendet.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage,

- konkrete Stadträume in ihrer Komplexität und Vielfalt analytisch zu erfassen.
- zeitgenössische urbane Phänomene zu beobachten und zu entschlüsseln, zu deuten und in ihren jeweiligen Kontext einzuordnen.
- Referenzen räumlich orientierter Strategien für die Entwurfs- und Planungspraxis als Methoden und Werkzeuge im Entwurf einzusetzen
- wichtige zeitgenössische Grundkonzepte des Städtebaus, wie städtischer Mischung, Ordnung, Dichte, Öffentlichkeit, etc. zu überblicken und damit in entwerferischen Ansätzen zu argumentieren, und damit
- veränderte gesellschaftliche Tendenzen kreativ in urbane Projekte zu integrieren.

Teaching and Learning Methods:
Vorlesungen werden durch Übungen begleitet. Die Teilnahme an den Vorlesungen vermittelt das notwendige Wissen, das in den Übungen exemplarisch zur Anwendung gebracht wird. Die Recherche und Analyse des Kontextes als eine elementare Voraussetzung architektonischen Planens und Entwerfens wird trainiert. Dabei kommen zusätzlich unterschiedliche Medien der Präsentation zur Anwendung. Damit wird der Zusammenhang von inhaltlicher Aussage und Medien der Darstellung weiter trainiert.
Die als Prüfungsleistung zu erbringenden Übungsaufgaben und thematische Erarbeitung zum Prüfungsgespräch werden von den Studierenden in Eigenstudium sowie unter unterstützender Anleitung bearbeitet

Media:
Vorlesung, ggfs. Stadtwanderung, Exkursion, (weiterführende) Literaturrecherche und Internetrecherche.

Reading List:
Weiterführende Literatur wird themenspezifisch in den Vorlesungsveranstaltungen bekanntgegeben

Responsible for Module:
Mark Michaeli, Prof. Dipl.Arch. ETH

Courses (Type of course, Weekly hours per semester), Instructor:
Ergänzende Einführung Städtebau (Vorlesung, 2 SWS)
Michaeli M, Lemberger E, Numberger J

Städtebau: Städtebau (Vorlesung, 2 SWS)
Michaeli M, Lemberger E, Numberger J
For further information in this module, please click campus.tum.de or here.

Module Description

AR30133: New Materials | Neue Werkstoffe [NM]

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter semester
Credits:* 3	**Total Hours:** 60	**Self-study Hours:** 40	**Contact Hours:** 20

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

Description of Examination Method:
Zum Abschluss des Seminars werden die erworbenen Kenntnisse in einer praktischen Übung zu den Themen der Vortragsreihe (Gastvorträge) umgesetzt.

In der praktischen Übung wird ein Kurzentwurf erarbeitet, der für eine vom Lehrstuhl gestellte überschaubare Baumaßnahme ein Anwendungsbeispiel eines besprochenen Werkstoffes aufzeigt. Die Aufgabe des Kurzentwurfs wird so gewählt, dass Konzeption und Ausarbeitung innerhalb kurzer Zeit zu bewältigen ist.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
8-semestriges Architekturstudium
Grundwissen im Bereich Baukonstruktion und Baustoffkunde

Content:
In Vorträgen werden Materialeigenschaften, gestalterische Möglichkeiten und ökologische Aspekte neuer Werkstoffe besprochen sowie deren Herstellungstechniken untersucht.

Dabei rücken wechselweise aktuelle Neuheiten hoch-technologischer Entwicklungen und beispielsweise Baustoffe aus recycletem, wiederverwendetem oder transformiertem Material in den Fokus. Die Auseinandersetzung mit unterschiedlichen Eigenschaften hinsichtlich Langlebigkeit, der Sondermüllfrage sowie der Energien im Herstellungsprozess bilden einen Ausgangspunkt für die Materialwahl in der Architektur.

Der Zusammenhang von architektonischer Form, Baustoffen und Baukonstruktion bildet das zentrale Thema des Kurses und wird abschließend in einem Kurzentwurf zum Thema exemplarisch angewandt.

Intended Learning Outcomes:
Das Verständnis von Eigenschaften, technischer Leistungsfähigkeit und Anwendungsmöglichkeiten der behandelten Materialgruppen und deren Herstellungstechniken bildet einen Rahmen für die Auseinandersetzung mit der Materialfrage in der Architektur.

Bestehende Materialanwendungen und Konstruktionen sollen hinsichtlich ihrer Eigenschaften und des materialgerechten Einsatzes vor dem Hintergrund neu auftretender Produkte und Techniken bewertet und hinterfragt werden.

Nach der Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage, das Anwendungspotential neuer Werkstoffe zu verstehen, zu bewerten und anzuwenden.

Teaching and Learning Methods:
Die Inhalte der Lehrveranstaltung werden in mehreren Vorlesungen und Vorträgen durch Gastreferenten aus der Forschung, der Industrie oder aus dem öffentlichen Bereich besprochen. Die behandelten Materialgruppen werden so spezifisch und von mehreren Standpunkten beleuchtet.

Je nach Semesterthema werden die erworbenen Kenntnisse in einer praktischen Übung in Form eines Kurzentwurfs zu den Themen der Vortragsreihe (Gastvorträge) umgesetzt. Dieser wird in einer abschliessenden Veranstaltung besprochen.

Media:
Beamerpräsentationen

Reading List:
Christiane Sauer, "Made off... Neue Materialien für Architektur und Design", Die Gestalten Verlag, Berlin 2010, ISBN 978-3-89955-293-5
John Fernandez, " Material Architecture, emergent materials for innovative buildings and ecological construction", Architectural Press, an imprint of Elsevier, Oxford, Burlington 2006, ISBN 0 7506 64975
Prof. Dr.-Ing. Hermann Schäffler, Prof. Dr.-Ing. Erhard Bruy, Prof. Dipl.-Ing. Günther Schelling, "Baustoffkunde, Aufbau und Technologie, Arten und Eigenschaften, Anwendung und Verarbeitung der Baustoffe" Kamprath- Reihe, Vogel Buchverlag Würzburg 200, ISBN 3-8023-1817-X

Responsible for Module:
Musso, Florian; Em.Univ.-Prof. Dipl.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Neue Werkstoffe (Battle of Materials) (Seminar, 2 SWS)
Musso F, Heinsdorff M, Hartl B, Hirt C, Hutz M, Pungercar V, Reiner S, Wurm S
For further information in this module, please click campus.tum.de or here.

Module Description

AR30200: Sustainable Urbanism I | Sustainable Urbanism I

Version of module description: Gültig ab summerterm 2018

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

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

Description of Examination Method:
Die Prüfungsleistung des Moduls ist eine knappe wissenschaftliche Ausarbeitung in Form eines thematischen Exposees (2 A4-Seiten) zu einem individuell zu wählenden Fallbeispiel nachhaltiger räumlicher Entwicklung von Siedlungsräumen und einer Präsentation mit thematischen Rückfragen, die mit ¾ in die Bewertung einfließt.

Die Präsentation der Arbeit zielt hierbei auf die vertiefte Diskussion der im Fallbeispiel identifizierten Herausforderungen und Charakteristika ab und dient dem Nachweis der Fähigkeit Fragestellungen aus dem Bereich der Nachhaltigen Entwicklung von Stadt und Land aufgreifen zu können, eigenständig in der Praxis taugliche Fallbeispiele für die Thematik identifizieren und beschreiben zu können, sowie die eigene Fachkompetenz im interdisziplinären Kontext einordnen zu können. Im knappen schriftlichen Teil und einer mündlichen Präsentation wird die Fähigkeit zur Kommunikation von thematischem Ansatz, Methodik und Projektergebnissen in für die Praxisanwendung relevanten Medien nachgewiesen.
Empfehlungen zum Format des Exposees, sowie Abgabedaten und Daten für das Präsentationsgespräch werden in der ersten Veranstaltung des Semesters bekannt gegeben.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
- Grundkenntnisse aus den Bereichen Städtebau und Urbanisierungsprozesse sind hilfreich (erworben, z.B. im Fach AR20091 oder AR20016 oder äquivalenten Veranstaltungen anderer Studiengänge und Universitäten /Hochschulen) aber nicht zwingend erforderlich.
Achtung: AR 30200 stellt KEINE Grundlagenvorlesung im nachhaltigen Städtebau dar! Hierzu werden Veranstaltungen AR 20016 im Bachelor oder AR 20091 im Master (ohne Master Architektur) empfohlen.
- einfache Grundkenntnisse im wissenschaftlichen Arbeiten mit Quellen werden vorausgesetzt

Das Fach kann thematisch mit AR20223 kombiniert werden und so eine vertiefte Durcharbeitung ermöglicht werden.

Content:
Städtebau und Nachhaltige Entwicklung von Stadt und Land ist eine komplexe inter- und transdisziplinäre Aufgabe. Gängigen Nachhaltigkeitsmodellen entsprechend vereint sie ökologische, gesellschaftliche und ökonomische Aspekte mit zentralen Fragen der Umbaufähigkeit eines spezifischen räumlichen Bestandes.
Der Lehrstuhl für Nachhaltige Entwicklung fokussiert dabei die Frage nach der konkreten Umsetzung in räumlich-spezifische Situationen hinsichtlich förderlicher Kombinationen von Raumstrukturen, Governancemodellen und Prozessen, sowie zielführendem Ressourceneinsatz in der Transformation zu nachhaltigeren urbanen Systemen. Dem Städtebauer und Architekten fällt in der Praxis dieser Prozesse die Rolle des Identifizierenden und Überblickenden, aber auch des Konzipierenden und Entwerfenden zu.

Die Lehrangebote auf dem Masterniveau erweitern zum Zwecke des Erwerbs dieser Kompetenzen die klassischen Lehrformate um Modelle des „forschenden Lernens“ in denen Studierende angeleitet werden, ihr eigenes, fachspezifisches Wissens in den interdisziplinären Kontext zu übertragen und dort anzuschließen, sowie Vorschläge zur Synthese in anwendbaren Strategien und Werkzeugen zu erarbeiten.

Beim Fachangebot AR30200 - Sustainable Urbanism 1 handelt es sich nicht um eine Übersichts- oder Grundlagenvorlesung zum Thema Nachhaltige Entwicklung von Stadt und Land oder nachhaltiger Städtebau!

Sie zielt vielmehr auf die beispielhafte thematische Vermittlung von komplexen Fragestellungen entlang eines (semestrig wechselnden) thematischen Schwerpunkts.
Entlang dieses zu Beginn der Vorlesungszeit bekannt gegebenen Semesterschwerpunktes wird ein Einblick in typische Problemlagen, Herausforderungen und Lösungsansätze vermittelt. Die Einbindung von Gastreferierenden aus unterschiedlichen disziplinären Umfeldern in Forschung und Praxis ermöglich eine breite Diskussion des Themenschwerpunktes. In Vorbereitung zur Prüfung werden die Studierenden eigene Beispiele aus Ihrem Umfeld identifizieren, welche der Illustration der in der Vorlesungsreihe vorgestellten diskutierter Problematiken dienen können. Der Lehrstuhl unterstützt dabei die Beispielwahl und -erarbeitung in (bei Bedarf wahrnehmbaren) individuellen Arbeitsgesprächen.

Intended Learning Outcomes:
Entlang eines beispielhaft ausgewählten thematischen Schwerpunktes erwerben die Studierenden einen Einblick in die Herausforderungen der nachhaltigen räumlichen Entwicklung von Siedlungsräumen. Sie sind nach erfolgreicher Teilnahme an der Veranstaltung in der Lage den interdisziplinären Kontext zu überblicken und ihre fachspezifischen Kompetenzen in diesem interdisziplinären Kontext zu verorten. Sie entwickeln die Fähigkeit, beispielhaft benannte Herausforderungen in ihren eigenen (räumlichen) Kontext zu übertragen, die Charakteristika

identifizierter Fallbeispiele (z.B. mit vermittelten Analyse- und Darstellungsmethoden) zu erarbeiten, in einer knappen Präsentation zu kommunizieren und fachspezifisch zu diskutieren.

Teaching and Learning Methods:
Vorlesungen, die den Themenrahmen vorgeben, mit angekoppelter, individuell zu leistender Übertragungsleistung in Form einer Fallbeispielidentifikation und -erarbeitung.
Dieser Prozess wird (auf Nachfrage durch Studierende) durch Betreuer in individuellen Workshops unterstützt.

Media:

Reading List:
Wird themenspezifisch mit der ersten Veranstaltung im Semester bekanntgegeben.

Responsible for Module:
Michaeli, Mark; Prof. Dipl. Arch. ETH

Courses (Type of course, Weekly hours per semester), Instructor:
Sustainable Urbanism I (Vorlesung, 2 SWS)
Michaeli M, Klawiter S, Lemberger E, Numberger J, Seeholzer S
For further information in this module, please click campus.tum.de or here.

Module Description

AR30212: Biogenic Building Materials | Biogene Baustoffe

Version of module description: Gültig ab summerterm 2018

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

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

Description of Examination Method:
Die Prüfungsleistung besteht aus einer schriftlichen Klausur mit einer Dauer von 60 Minuten am Ende des Semesters.
Durch das Beantworten von Fragestellungen zu Terminologie, Eigenschaften, Herstellungsprozessen und Anwendungsbereichen nachwachsender Baustoffe weisen die Studierenden ihr grundlegendes Verständnis zu Biogenen Baustoffen nach. Außerdem können Aufgabenstellungen vorhanden sein, die das eigenständige Anwenden und Weiterdenken des erlernten Wissens erfordern. Die Antworten sind zum Teil auch als skizzenhafte Darstellungen, Ankreuzen von Mehrfachantworten oder eigenständige Formulierungen zu leisten.

Repeat Examination:

(Recommended) Prerequisites:

Content:
Den Studierenden wird ein Überblick über das Spektrum und die Bedeutung nachwachsender Baustoffe an die Hand gegeben. Der Schwerpunkt dabei liegt auf der Verwendung von dem Material Holz und Holzwerkstoffen. Neben bewährten Konstruktionen werden innovative Materialentwicklungen und deren ökologisches Potenzial untersucht. Dabei wird der Zusammenhang von architektonischem Entwurf, Baustoff und Baukonstruktion thematisiert.

Intended Learning Outcomes:
Die Studierenden sind nach Absolvieren des Moduls in der Lage:
- fachliche Terminologie Biogener Baustoffe zu benutzen
- die technischen und ökologischen Eigenschaften der Baustoffe zu differenzieren und zu beurteilen

- die jeweiligen Herstellungsprozesse und Anwendungsbereiche nachwachsender Baustoffe zuzuordnen, auseinanderzuhalten und zu bewerten

Teaching and Learning Methods:
Die Lehrveranstaltung wird als wöchentlich stattfindende Vorlesungsreihe abgehalten und ist in verschiedene Teilbereiche der „Biogenen Baustoffe“ gegliedert. Um die Grundlagen dieser Themenfelder zu vermitteln, beinhalten die Präsentationen oftmals Fotografien, Pläne und Skizzen von gebauten Beispielprojekten, wodurch ein Bezug zur Praxis hergestellt wird. Oftmals werden diese durch Illustrationen, schematische Darstellungen und Piktogramme ergänzt, damit die spezifischen Zusammenhänge und Abhängigkeiten verständlich und nachvollziehbar dargestellt werden. Textliche und bildhafte Auszüge aus Fachliteratur, Baurichtlinien oder Lexikon werden gezeigt, um die Definition von Fachbegriffen und Rahmenbedingungen zu gewährleisten. Diagramme und Tabellen dienen der Vermittlung von technischen Daten und zeigen deren Verhältnismäßigkeiten zu einander auf. Digitale Auszüge aus den Vorlesungen unterstützen das geforderte Selbststudium und ergänzen die von den Studierenden geforderten, eigenständig angefertigten Notizen. Diese bilden die Grundlage für die schriftliche Prüfung am Semesterende.

Media:
Präsentationen

Reading List:
Abhängig vom Themenschwerpunkt werden in den Vorlesungen weitere Literaturangaben gegeben.

Holzmann, Wangelin, Bruns
"Natu#rliche und pflanzliche Baustoffe", Vieweg+Teubner Verlag, 2012
Salthammer, Marutzky

Responsible for Module:
Kaufmann, Hermann; Prof. Dipl.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Biogene Baustoffe (Vorlesung, 2 SWS)
Birk S, Anneser H, Kohaus M, Dietrich Z, Faber J, Huth T, Völkel A, Wolfertstetter D
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, Bratoev I, Förster N, Schubert G
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:
Im Vorlesungsteil 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)
Petzold F, 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:
Algorithmic Design (Seminar, 4 SWS)
Bratoev I, Petzold F
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:

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

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:** 20	**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:
Performance Based Design (Seminar, 4 SWS)
Petzold F, Schubert G, Förster N
For further information in this module, please click campus.tum.de or here.

Module Description

AR30400:

Version of module description: Gültig ab summerterm 2019

Module Level:	Language:	Duration:	Frequency:
Master			
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
6	180	160	20

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

Description of Examination Method:
Die Prüfungsleistung des Moduls ist ein semesterbegleitend zu erarbeitendes Lernportfolio. In Einzelarbeit dokumentieren die Studierenden erkannte Zusammenhänge und Verknüpfungen zeitgenössischer städtischer und vorstädtischer Strukturen und deren Transformationsmuster sowie ihre individuelle Reflektion erkannter Ansätze nachhaltiger Raumprozesse. Zudem sind im Lernportfolio drei räumliche Situationen im Universitätsumfeld genau zu untersuchen, um nachzuweisen, dass sie Instrumente des Städtebaus und des Stadtbeobachtens einsetzen und testen können.
Das gesamte Lernportfolio ist zum Prüfungstermin in grafischer Darstellung als ein Poster zu präsentieren.

Repeat Examination:

(Recommended) Prerequisites:
Kein Vorwissen erforderlich. Für Studierende mit BA Architektur der TUM ist dieses Format leider nicht wählbar.

Content:
Das Modul vermittelt systemische Einblicke in die Grundprinzipien von Stadtplanung und Stadtentwicklung (Urban Development), die auf den Grundprinzipien des nachhaltigen Städtebaus basieren. Schwerpunkte sind (unter anderem)
- Wahrnehmung und Erkundung von Schlüsselfragen von Transformation, Techniken zur Problemerkennung und Konzeptualisierung von Lösungsstrategien im urbanen Raum,
- Anwendung beispielhafter morphologischer und physiologischer Indikatoren der Stadtstruktur sowie
- der Darstellung von Stadterneuerungsprozessen in Best-Practice-Projekten.

Das Modul konfrontiert den Studierenden mit einem Repertoire an Möglichkeiten, komplexe räumliche, ästhetische, soziale, kulturelle, ökologische und nachhaltige Qualitäten in zeitgenössische Wohnumgebungen zu integrieren. In physischen Begegnungen mit der Stadt (Workshops vor Ort) werden wichtige städtische Umgebungen und Stadtphänomene im wirklichen Leben untersucht.

Intended Learning Outcomes:
Nach absolvieren des Moduls können die Studierenden die gegenwärtigen Transformationsmuster zeitgenössischer städtischer und vorstädtischer Strukturen einschließlich der Zusammenhänge zwischen ökologischen, gesellschaftlichen und wirtschaftlichen Faktoren erkennen und verstehen. Anhand von Beispielen können die Studierenden grundlegende Ideen und Ansätze für nachhaltige Raumprozesse reflektieren und verstehen. Sie sind in der Lage die Instrumente des Städtebaus und des Stadtbeobachtens in konkreten Situationen einzusetzen und im tatsächlichen Kontext zu testen.

Teaching and Learning Methods:
Vortragsreihe, die in ein Praxisseminar einfließt: In der Vorlesung werden grundlegende städtebauliche Themen

eingeführt, die dann im Workshop zur Erkundung aktueller Handlungen individuell angewendet werden.
die dann bei einem Stadtspaziergang, bei der Bestandsaufnahme einer kleinräumlichen städtischen Situation und bei der Beobachtung und Dokumentation von Nutzerverhalten individuell angewendet werden.

Media:
Keynote, Übungsblätter, Skizzenpapier

Reading List:
Relevante Literaturhinweise werden in den Vorlesungen präsentiert.

Responsible for Module:
Prof. Mark Michaeli

Courses (Type of course, Weekly hours per semester), Instructor:
Ergänzende Einführung Städtebau (Vorlesung, 2 SWS)
Michaeli M, Lemberger E, Numberger J
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

Basics of Robotic Fabrication

Version of module description: Gültig ab summerterm 2020

Module Level: Bachelor/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:
The focus of the seminar Basics of Robotic Fabrication is the teaching of conceptual as well as practical tech-nical basics of digital and robotic fabrication in architecture. In the seminar, essential theoretical and practical foundations of computer-aided integrated design and fabrication processes are conveyed, as well as the gen-eral use of robotic technologies are discussed. These foundations are practically deepened by exercises. The examination credits of students are provided in the form of written exercises. In this, it should be proven that important teaching contents and functional relationships are understood.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
The seminar requires basic knowledge of scientific work. Basic knowledge of the software Rhino and Grass-hopper and programming in Python is an advantage.

Content:
The seminar focuses on basic methods of digital, parametric and algorithmic, design as well as related robotic fabrication techniques and provides incentives for learning basic computational literacy in this field. Based on simple examples, such as the robotic construction of masonry, students learn the basics of parametric and al-gorithmic design with the software Rhino and Grasshopper, as well as the programming language Python. Stu-dents learn the theoretical background and basic implementation details of basic data structures and algo-rithms, and how to solve real world problems using the COMPAS and COMPAS_FAB frameworks and other open source libraries. Existing robotic systems from the "Augmented Fabrication Lab" allow designs from the seminar to be prototypically implemented.

Intended Learning Outcomes:
The intended learning outcomes include to
• understand the theoretical background of basic data structures,
• apply the basic principles of algorithmic design,
• implement basic versions of prevalent algorithms related to architectural geometry and robotic fabrica-tion,
• use common CAD tools as interfaces to self-implemented solutions, and
• understand the scope and relevance of computational methods for architectural research and practice.

Teaching and Learning Methods:
The seminar consists of lecture series and assignments, several tutorials and project-related assignments.
The topics cover:
• Introduction to Python programming
• Introduction to the open source framework COMPAS (https://compas-dev.github.io/) and COMPAS_fab (https://gramaziokohler.github.io/compas_fab/latest/)
• Introduction to the processing of geometry, data structures, robot programming and interfaces
• Domain-specific case studies (e.g. architectural geometry, robot 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 (Seminar, 4 SWS)
Dörfler K, Atanasova L, Dielemans G, Fleckenstein J
For further information in this module, please click campus.tum.de or here.

Module Description

AR30453: New Fields in Urban Design | Neue Horizonte des Städtebaus

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
The course aims to have students extend their knowledge towards the particular topic area in its relation to Urban Design. The coursework will be evaluated through the final presentation and booklet. This includes the identification of a relevant aspect of the topic developed in the seminar, the development of hypotheses, their elaboration through relevant case studies, and the choice of a plausible approach developed in the form of a project. The final requirements of the course are in the form of a digital presentation – orally presented and submission of a booklet including written and visual elaboration.

Repeat Examination:

(Recommended) Prerequisites:
The seminar is intended for students of all disciplines who are interested in future changes in cities and related fields of Urban Design. Basic knowledge of Urban Design is not necessary, but a high level of interest is expected.

Content:
The interdisciplinary module deals with the question of which technical developments could decisively change our cities in the next decades and how to respond to them through interdisciplinary associations. The seminar will involve current ideas from basic research yet to be thoroughly embedded within urbanistic discourse with an aim to bring those into an exploration, discussion and prototyping levels. In the first phase of the course, knowledge from different disciplinary perspectives will be built up on the specifically defined topic by providing literature as well as expert lectures. In the second part of the seminar, this knowledge will be deepened by case

studies bringing an application-based perspective as a preparation for the third part of the seminar, in which prototypical project proposals will be tested in groups of 2-4 students.

Intended Learning Outcomes:
After participating in the module "New Fields in Urban Design", you will be able to develop and discuss urban design issues in an interdisciplinary team and synthesize and discuss them in the frame of a project. Throughout the course, you will understand fundamental questions of urban design and new perspectives related to future developments of our cities, especially with regards to technological issues.

Teaching and Learning Methods:
The module will be conducted in several meetings or face-to-face sessions, consisting of introduction, key inputs, and guided teamwork into project development into a presentation.

Media:
Written article, drawing and graphical representations, digital presentation(pdf/powerpoint).

Reading List:
References will be adapted to the respective topic and published on the website of the professorship and/or in Moodle.

Responsible for Module:
Prof. Ben Boucsein Boucsein@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Precision Landscapes (New fields in Urban Design (supported by DesignFactory) (Seminar, 4 SWS)
Boucsein B, Fettahoglu Özgen E, Bar-Sinai K, Shaked T
For further information in this module, please click campus.tum.de or here.

Module Description

AR72047: Green Typologies - MA | Green Typologies - MA [GTYPE_MA]

Version of module description: Gültig ab summerterm 2018

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:

Based on the quality of the relevant research, extent of understanding of open space and architectural phenomena and hybrid structures is examined.
Discussions of the course content together with the teacher and the group will show the extent of students' learning. Documentation produced in individual work will illustrates to what extent the students have internalized and can apply their knowledge. This is examined on the basis of coherent presentation of the graphic analyses, refurbishments, and their own approaches.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
The students should have an interest in topics of open space design and ecological issues (microclimate, water balance, etc.), having previously taken part in relevant courses.

Content:
At the center of the Green Typologies module is the exploration of new architectural and open-space typologies characterized by the innovative use of plants. Possible areas of focus are:

- Spatial conception
- Vegetation concepts
- Construction and technology
- vegetation use and vegetation technology
- hybrid structures (nature-technology; city-landscape; architecture-open space)
- temporality, process, transformation
- context (spatial, social, ecological)
- Use and program

- Relationship between public and private
- Habitat and quality of residence
- Biodiversity

Intended Learning Outcomes:
After the completion of this module students will have an understanding of a new kind of open space, architectural phenomenon, and hybrid structures. It will be possible for them to apply this knowledge in spatial, technical, social and ecological contexts. In a next step, they can systematically analyze vegetative and spatial concepts, abstract them graphically, and evaluate them. The students are able to give fair assessments of developments with thematic focus on temporality, process and transformation. On this basis, they are able to independently develop architectural and open space approaches and present them logically with articulation and professionalism.

Teaching and Learning Methods:
The module is based on different methodological approaches: the teaching of basic knowledge and a general thematic overview by lectures, which may be also supplemented by guest speakers. A deeper understanding of selected aspects of the topic is provided through example projects.
The results, to be developed in self-led research, will be regularly discussed in group with supervision of the teacher. In supervised pair or group work (maximum three students), graphical analyses are prepared and students' own approaches developed.
The intermediate results are regularly presented and discussed together with the teacher and group in order to sharpen the project goals. After a comprehensive presentation of the results and subsequent discussion of the contents with the teacher and group, a documentation of individual work will follow.

Media:
The contents, the slides of the lectures as well as those of the guest lectures of external experts, basic literature sources and all further basics are made available on the TUM learning platform or by email.

Reading List:

Responsible for Module:
Ferdinand Ludwig

Courses (Type of course, Weekly hours per semester), Instructor:
Green Typologies (digital tools for living architecture design) (Seminar, 4 SWS)
Shu Q
For further information in this module, please click campus.tum.de or here.

Module Description

AR72048: Green Technologies MA | Green Technologies MA [GTECH_MA]

Version of module description: Gültig ab summerterm 2018

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:
The module exam is a scientific documentation with a conceptual and a analytical part. This textual and graphic analysis of basics in the form of a study work shows the proof of learning of the module. This is accompanied by a presentation and discussion in order to test the communicative competence of presenting scientific topics to an audience.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
The students should have an interest in topics of open space design and ecological issues (microclimate, water balance, etc.), having previously taken part in relevant courses.

Content:
At the center of Green Technologies module is the exploration of building techniques in which design of plants is functional, spatial, and creative.
Possible areas of focus are:

- Attitudes to "Green Architecture"
- Designing with growth processes
- vegetation technologies
- The greening of Buildings
- Green and blue-green infrastructure
- Baubotanik
- (city) climate and (city) ecology

Intended Learning Outcomes:
After attending this module, students are able to:
- define important terms in the field of green technologies.
- reflect the imparted fundamentals of green architecture and infrastructure.
- recognize, use and discuss the relationships between urban water management, vegetation use and urban climate.
- discuss the processes of "building" and "growing" in their diversity and translate them into hybrid concepts.
- select suitable vegetation approaches for construction tasks in the field of "green architectures".
- apply knowledge from the course of green technologies at different scales in order to independently analyze projects and to be able to develop their own concepts.
- present adequately the developed analyses and / or concepts through texts and graphics.

Teaching and Learning Methods:
The module is divided into two methodical parts:
- The teaching of fundamental knowledge and a general thematic overview through lectures, which may be also supplemented by guest speakers. On the basis of example projects, a deeper understanding of selected aspects of the topic is explored.
- Through self-led study in individual or group work, understanding of the course content will be extended and deepened in the form of guided content research, textual and graphic analysis, and through example concept developments. Regular presentations and discussions with the course group and teacher will help sharpen the project goals.

Media:
Slide Presentations, Drawings, CAD, Power-Point, Adobe Creative Suite

Reading List:

Responsible for Module:
Ferdinand Ludwig

Courses (Type of course, Weekly hours per semester), Instructor:
Green Technologies (Lebende Architektur) (Seminar, 2 SWS)
Ludwig F, Well F

Green Technologies (Lebende Architektur) (Vorlesung, 2 SWS)
Ludwig F, Well F
For further information in this module, please click campus.tum.de or here.

Module Description

AR72053: Renewable Energies and Landscape Aesthetics | Erneuerbare Energien und Landschaftsästhetik

Version of module description: Gültig ab winterterm 2018/19

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

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

Description of Examination Method:
The exam is a scientific elaboration with a self-developed topic in the field of renewable energies as landscape coining structures, focussing on personal reflections of landscape aesthetics. Technical details should be briefly explained. Reflection means to a) critically discuss and/or b) conceptualize in a design - in any case not to cite or reproduce others positions, but to develop and explain an own concept.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
Experience in planning and designing concepts of spacial structures, e.g. by successful participation in projects

Content:
1 History of Energy and Landscape
2 Landscape Theory
3 Landscape Aesthetics
4 Fundamental Ecological Aspects of Energy Production
5 Arts and Design with Renewable Energies
6 Legal Framework
7 Structural Analysis of Landscape
8 Planning Theories
9 Wind Energy and Landscape
10 Solar Energy and Landscape
11 Biomass and Landscape

Intended Learning Outcomes:
After attending the module, constituting on present skills in planning and designing and on the specific methods introduced by the lecture, students are able to develop a landscape architectural task at the regional scale by means of a spatial-structural analysis and design concept.

Teaching and Learning Methods:
The course in the module are a lecture and a seminar, that can be offered as a multi-day excursion.

Media:
Slide Presentation, excursion

Reading List:
Script zur Vorlesung, FAQ zur Ausarbeitung
Schöbel, Sören: Windenergie und Landschaftsästhetik. Berlin 2012
Schöbel, Sören: Renewable Energies - Landscapes of Reconciliation? In: Topos 70/2010 (mit Andreas Dittrich)

Responsible for Module:
Prof. Sören Schöbel-Rutschmann

Courses (Type of course, Weekly hours per semester), Instructor:
Erneuerbare Energien und Landschaftsästhetik (Vorlesung mit integrierten Übungen, 4 SWS)
Schöbel-Rutschmann S [L], Schöbel-Rutschmann S
For further information in this module, please click campus.tum.de or here.

Module Description

BGU52018: Interactions of Land-use and Transport | Wechselwirkungen von Raum- und Verkehrsplanung

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:** 60	**Contact Hours:** 30

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

Description of Examination Method:
The examination form for this module is a 60 minutes written exam.
The goal is to verify that the students are able to understand the basics of land use and transport interactions. The students are able to evaluate strategies of land use and transport development and create concepts for sustainable transport demand management.
Students need to develop an argumentation and transfer knowledge in order to be able to answer the comprehension and application questions.
The use of helping material during the exam is not permitted.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
- Transport supply, transport demand and impacts of transport
- Interactions of land use and transport
- Accessibility
- Regional land use and transport concepts
- Spatial planning instruments
- Neighborhood mobility
- Mobility management, transport demand management

Intended Learning Outcomes:
At the end of the module students are able to
- understand the interactions between land use and transport demand,

- evaluate transport demand management strategies and
- create concepts for sustainable transport demand management.

Teaching and Learning Methods:
The module consists of a lecture supported by a PowerPoint presentation, where opportunities for discussion are given. Furthermore, a half day excursion is organized, which aims to emphasize the relations between land use and transport planning on site. Expert guest speakers are invited for certain topics. A 30-minute test exam takes place mid-semester. The test exam is voluntary and will not be graded.

Media:
PowerPoint presentation, whiteboard, scientific papers, guest lectures.

Reading List:
Bertolini, Luca. 2017. Planning the mobile metropolis. Transport for people, places and the planet. Palgrave.
Gehl, Jan. 2010. Cities for people. Island Press.

Responsible for Module:
Wulfhorst, Gebhard; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Interactions of land-use and transport (Vorlesung, 2 SWS)
Wulfhorst G [L], Wulfhorst G, Kinigadner J, Jehle U
For further information in this module, please click campus.tum.de or here.

Module Description

BGU62051: Sufficiency in Architecture and Engineering | Suffizienz im Bauwesen

Version of module description: Gültig ab summerterm 2020

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 performance record consists of a scientific paper with a final presentation of the results, whereby the presentation is included in the overall grade with 20%.
With the scientific elaboration and the associated presentation, the students demonstrate that they have understood and can apply the different aspects of sufficiency. In addition, the students should be able to develop strategies and approaches to solutions on the topic of sufficiency in the building industry by themselves.
The scientific paper has to be uploaded on Moodle.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
What does sufficiency mean? Sufficiency as a life goal? What role does sufficiency play in architecture and engineering? These and other questions are centered around one of the core areas of the sustainability concept – not only with regard to architecture and engineering. The seminar therefore explores the significance of the “sufficiency” concept to our quality of life and the consumption of resources this involves. Foundations and various aspects of sufficiency and of the sustainability concept in architecture and engineering are discussed and considered in the context of current developments and plans by experts from various disciplines (natural sciences, engineering and the humanities). Apart from fundamental aspects, recent findings from research and practice in the field of sufficiency are presented and explored in more detail in the paper drafted by the participants.
Structure / content:

Part 1: The lectures given by experts from various fields of specialization during the seminar will present and discuss the following topics in the light of the concept of sufficiency:
• Philosophy
• Economics
• Sociology
• Technology
• Engineering
• Architecture / landscape architecture
• ..
The contents and topics are conveyed in the form of a lecture, based on vivid presentations using charts, pictures and short films. In addition, interesting articles and recommended literature are made available for download on the website.
Part 2: In the second part of the seminar, selected topics are studied in greater depth by the students while special topics are explored by participating in related events or excursions

Intended Learning Outcomes:
Students who have completed the module have gained an understanding of the elements of the sufficiency concept and are able to apply them to their future professional activity in designing, planning and implementing urban districts and buildings.

Teaching and Learning Methods:
The module consists of a seminar. The seminar firstly consists of lectures presented by experts with various specializations from research and practice. The lectures are intended to create an awareness of the topic among students, to encourage them to thoroughly study it and to give them insights into the topic of sufficiency from various perspectives. Secondly, the seminar consists of activating teaching methods, which include presentations given by the students, discussions, research and group work. Therefore, the independent development of strategies and solutions is encouraged.
In addition, excursions and visits to relevant events are offered. This approach enables an enhanced transfer of knowledge beyond the ambit of the TUM.

Media:
PowerPoint, script, films, worksheets

Reading List:
Fuhrhop, Daniel (2015): Verbietet das Bauen! Eine Streitschrift. 2. Auflage. München: oekom Verl.
oekom e. V. (Hg.) (2013): Politische Ökologie. Suffizienz als Schlüssel zu mehr Lebensglück und Umweltschutz. Oekom e.V. München: Oekom-Verl. (Politische Ökologie, 135).
Stengel, Oliver (2010): Suffizienz. Dissertation. Wuppertal Institut für Klima, Umwelt, Energie.
Welzer, Harald (2013): Selbst denken. Eine Anleitung zum Widerstand. 5. Aufl. Frankfurt am Main: Fischer.

Responsible for Module:
Werner Lang sekretariat.enpb.bgu@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Suffizienz im Bauwesen (Seminar, 4 SWS)
Lang W [L], Hernández Chamorro A, Lang W, Schwering K
For further information in this module, please click campus.tum.de or here.

Module Description

BGU62057: Special Topics in Sustainable Urbanism | Sonderthemen des nachhaltigen Städtebaus [IDP Urban]

Version of module description: Gültig ab winterterm 2021/22

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 certificate of achievement is a project work and consists of the processing of an urban design in new or existing buildings in the context of sustainable neighborhood development. The project work is carried out in a group.

With the final presentation, the students should show that they can present the scientific development process of their planning/building concept as well as the essential findings in a clear and condensed form.
The results of the respective work sections are presented to guests, lecturers and professors in interim or final presentations.

Repeat Examination:

(Recommended) Prerequisites:

Content:
The seminar is intended to prepare the students for the challenges of real planning situations and to provide them with the essential process knowledge and tools for mastering the task in a planning team consisting of approx. 5 interdisciplinary students per group.
In the IDP Urban seminar, the urban planning fundamentals are worked out at the neighborhood level. Existing urban spaces are to be analyzed and evaluated with regard to their sustainability. The knowledge from accompanying seminars and lectures will be applied. During the seminar students will develop a vision for the neighbourhood of the future. In interdisciplinary groups, this vision will be implemented as an urban planning concept with the goal of a future-oriented and

sustainable development of the neighbourhood. In the following semester, this solution will be developed in greater depth on the building and detail level.
The goal of this seminar is to develop positive urban planning foundations for resource-saving, low-emission and socially compatible urban development. The holistic concept includes the following topics: urban and architectural design, social sustainability, mobility, energy concept, green and blue infrastructure and ecology. The results of the respective work phases will be presented to guests, lecturers and professors in interim and final presentations.

Intended Learning Outcomes:
In the IDP Urban seminar students will develop the urban planning fundamentals at the neighborhood level. Existing urban spaces will be analyzed and evaluated with regard to their sustainability. The knowledge from accompanying seminars and lectures will be applied. During the seminar students will develop a vision for the neighbourhood of the future. In interdisciplinary groups, this vision will be implemented as an urban planning concept with the goal of a future-oriented and sustainable development of the neighbourhood. In the following semester, this solution will be developed in greater depth on the building and detail level.

Teaching and Learning Methods:
Seminar format with interactive workshops, field trips, and presentations.

Media:

Reading List:
Bott, H., Grassl, G. C., & Anders, S. (2014). Nachhaltige Stadtplanung: Konzepte für nachhaltige Quartiere. [München]: Detail.
Ekardt, F. (2016). Theorie der Nachhaltigkeit: Ethische, rechtliche, politische und transformative Zugänge - am Beispiel von Klimawandel, Ressourcenknappheit und Welthandel (2., vollständig überarbeitete und aktualisierte Auflage). Baden-Baden: Nomos.
Friedman, T. L. (2009). Hot, flat, and crowded: Why we need a green revolution--and how it can renew America (Release 2.0, updated and expanded ; 1st Picador ed.). New York: Picador/Farrar, Straus and Giroux.
Heck, H.-D., & Meadows, D. L. (1972). Dennis Meadows [u.a.] Die Grenzen des Wachstums (The limits to growth, dt.).
McDonough, W., & Braungart, M. (2002). Cradle to cradle: Remaking the way we make things (First edition). New York: North Point Press.
Meadows, D. H., Meadows, D. L., & Randers, J. (1992). [Hauptband] (6. Aufl.). Die neuen Grenzen des Wachstums : die Lage der Menschheit: Bedrohung und Zukunftschancen / Donella H. Meadows: A. Stuttgart: Dt. Verl.-Anst.

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
IDP Urban (Sonderthemen des nachhaltigen Städtebaus) (Seminar, 2 SWS)
Lang W [L], Schade C, Schwering K, Staudt J
For further information in this module, please click campus.tum.de or here.

Module Description

BGU62058: Practice-oriented Aspects of Sustainable Urbanism | Praxisorientierte Aspekte des nachhaltigen Städtebaus [POASU]

Version of module description: Gültig ab summerterm 2021

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:
Independent development of strategies and approaches to solutions, which are presented in the form of an on-site presentation at the end of the semester. Through the examination in the form of a presentation, the students should prove that they are able to deal with current research topics over a period of one semester and to critically examine them. Various issues from architecture, urban and landscape planning as well as the fields of energy, water and mobility will be addressed and applied and evaluated in a research-related manner.
In interaction with the lecturers, typical problems are to be analyzed in a results-oriented manner and the solutions are to be brought into a meaningful context.
The form of the oral performance record allows iterative questions with increasing complexity and the individual approach to the students, which allows a realistic assessment of the competencies acquired in the context of the module.

Repeat Examination:

(Recommended) Prerequisites:
Participation in the course Sustainable Architecture, Urban and Landscape Planning.

Content:
The module directly refers to the field of work of the Chair of Energy Efficient and Sustainable Planning and Building (ENPB). This includes relevant issues from the fields of existing buildings as well as new construction, urban design, energy supply, resource consumption, circular economy in construction, climate change and adaptation.
The seminar includes the topic of sustainability in architecture, urban and landscape planning in European cities and serves as active excursion preparation for practice-oriented analysis of sustainable urban design on site in selected European cities.

Intended Learning Outcomes:
After participation, the students are able to apply the knowledge gained in their future work due to the in-depth, independent examination of specific individual aspects of sustainable urban planning. Furthermore, the participants will be able to place the selected individual topics or aspects in the overall context of sustainable urban planning and recognize the significance for their own actions. A holistic way of seeing and acting is promoted.

Teaching and Learning Methods:
The seminar "Practical Aspects of Sustainable Urban Design" builds on the course "Sustainable Architecture, Urban and Landscape Planning", which takes place in the winter semester. In the winter semester, a sustainability guide to a European city will be developed with the aim of completing it further in the summer semester and visiting the city for a week. The excursion is prepared by the students in interdisciplinary teams through subject-specific research and coordinating workshops, and they actively participate on site with presentations and visits. Through the excursion, the students receive the practical reference to the scientifically elaborated topics and acquire new competencies through supplementary specialized lectures and site visits.

Media:
Presentations, video

Reading List:
Hegger, Manfred ; Fuchs, Matthias ; Stark, Thomas ; Zeumer, Martin: Energie Atlas : Nachhaltige Architektur. Berlin: Walter de Gruyter, 2007.
Kaltschmitt, Martin ; Streicher, Wolfgang ; Wiese, Andreas: Erneuerbare Energien : Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. Berlin Heidelberg New York: Springer-Verlag, 2013.
Lenz, Bernhard ; Schreiber, Jürgen ; Stark, Thomas: Nachhaltige Gebäudetechnik : Grundlagen - Systeme - Konzepte. Berlin: Walter de Gruyter, 2010.
Gehl, Jan; Städte für Menschen; Jovis 2015

Responsible for Module:
Prof. Dr.-Ing. Werner Lang

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

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

Module Description

BGU62060: Building Biology. Principles of Healthy and Sustainable Planning and Building | Baubiologie. Prinzipien des gesunden und nachhaltigen Planens und Bauens

Version of module description: Gültig ab summerterm 2019

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** one-time
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 Modulprüfung wird in Form einer wissenschaftlichen Ausarbeitung in Zweiergruppen mit einer dazugehörigen 10-15 minütigen Präsentation der Ergebnisse abgenommen. Die Ausarbeitung dient der Anwendung gelernter baubiologischer Prinzipien zum Raumklima mit einem Schwerpunktthema entsprechend der Studienrichtung oder Präferenz. Während des Semesters werden Mid Term Leistungen als freiwillige Übungen abgefragt. In Gruppen bearbeiten die StudentInnen dabei Aufgaben im Rahmen von Ökobilanzen/Zertifizierungen und einer Exkursion. Die Ergebnisse dieser Übungen werden mit 5-10 minütigen Präsentationen dargestellt. Ziel ist Kompetenzen von Studenten höherer Semester im neuen Kontext anzuwenden und jüngeren Semestern die eigenständige Anwendung der Lehrinhalte zu ermöglichen. Die Ergebnisse fließen als Bonus mit 30% in die Gesamtbewertung der Leistungen der StudentInnen ein.

Repeat Examination:

(Recommended) Prerequisites:
keine

Content:
Es werden Raumklimafaktoren und bauphysikalische Zusammenhänge von Baustoffen, sowie die Innenraumluft belastende Faktoren chemischer, mikrobiologischer und elektrobiologischer Art vermittelt. Ferner werden die Prinzipien des gesunden und nachhaltigen Bauens und Planens durch Vermittlung von geeigneten Bauweisen und Baustoffen sowie entsprechender technischer Ausrüstung von Bauwerken erläutert. Ergänzt wird dieses durch die Vermittlung von Elementen ressourcenschonenden Bauens und Ökobilanz- bzw. Kreislaufwirtschaftskriterien.

Intended Learning Outcomes:
Nach erfolgreicher Teilnahme am Modul sind die StudentInnen in der Lage:
- das Raumklima beeinflussende Faktoren zu benennen
- den Einfluß von Faktoren auf die Innenraumluft zu verstehen
- eine sinnvolle Materialauswahl für geringe Innenraumluft-Belastungen zu treffen
- Planungsprinzipien für eine gesunde und nachhaltige, baubiologisch empfohlene, Bauweise (Baustoffe und Konstruktionen), und technische Ausstattung (Elekroinstallation, HLS-Syteme), anzuwenden
- Baustoffe zu analysieren und nach ihrer raumklimatischen Wirkung zu bewerten

Teaching and Learning Methods:
Vorlesung/Vortrag zur Vermittlung vom Lehrstoff in Kombination mit
aktivierenden Lernmethoden: Aktives Erarbeiten von Lehrinhalten durch - Aktivierung des Vorwissens in Form von Präsentationen selbsterarbeiteter Inhalte oder Kurzprotokolle
- Übungen als Hausarbeiten zum Anwenden von Lehrinhalten und zur Wiederholung in Form von Präsentationen oder Kurzreferaten
- Selbststudium zur Erarbeitung und Vorbereitung von Prüfungsleistungen
Sowie Exkursion:
- Zur anschaulichen Darstellung der baubiologischen Bauweise wird ein Leuchtturmprojekt besucht

Media:
Präsentationsprogramme, wie Powerpoint

Reading List:
Wege zum gesunden Bauen, Holger König, ökobuch Verlag, 9. Auflage 1998
Baubiologie in Frage und Antwort, Institut für Baubiologie + Nachhaltigkeit (Herausgeber), IBN-Verlag, 6. Auflage, September 2008
Lehmbau Regeln, Hrsg. Dachverband Lehm e.V. Vieweg + Teubner Verlag, 3. Auflage, 2009
Gesund und Ökologisch Bauen, Beate Rühl, Blottner Verlag, 2010
Lehm im Innenraum, Achim Pilz (Hrsg.) Fraunhofer IRB Verlag, 1. Auflage, 2010
Cradle to Cradle, Michael Braungart, William McDonough, Taschenbuch Piper Verlag, 2013
Handbuch Lehmbau, Gernot Minke, ökobuch Verlag, 8. Auflage 2012
Mit Sicherheit gesund bauen, Peter Bachmann, Matthias Lange (Hrsg.) Springer Vieweg Verlag, 2. Auflage, 2013
Stress durch Strom und Strahlung, Wolfgang Maes, IBN-Verlag, 6. Auflage, Mai 2013
Baubiologische Haustechnik, Frank Hartmann, VDE-Verlag, 2014
Biologisch bauen, renovieren, wohnen, Herbert Artelt, Reimer Verlag, August 2014
Einfach. Jetzt. Machen! Rob Hopkins, oekom Verlag, 2. Auflage 2014
Handbuch Strohballenbau, Gernot Minke, Benjamin Krick, ökobuch Verlag 3. Auflage, 2014
Gebaute Erde – Gestalten & Konstruieren mit Stampflehm, Martin Rauch, Edition Detail, 2015
Neues Bauen mit Holz, Marc Wilhelm Lennartz, Susanne Jacob-Freitag, Birkhäuser Verlag, November 2015
Reduzierung hochfrequenter Strahlung im Bauwesen: Baustoffe und Abschirmmaterialien, Peter Pauli, Dietrich Moldan, VDB Berufsverband deutscher Baubiologen e.V. 2015

StadtLandschaften, Christoph Bijok, IBN-Verlag, 2015
Bauen mit Holz. Wege in die Zukunft, Hermann Kaufmann, Winfried Nerdinger (Hrsg.), Prestel, 2016
Lehm und Kalkputze, Irmela Fromme, Uta Herz, ökobuch Verlag, 3. Auflage 2016
Ökologisches Baustoff-Lexikon, Wolfgang Linden, Iris Marquardt, VDE-Verlag, 4. Auflage 2017
Baubiologie. Kriterien und architektonische Gestaltung, Nurgül Ece, Birkhäuser Verlag 2018
Gesundes Bauen und Wohnen. Baubiologie für Bauherren und Architekten, Petra Lidl, Bettina Rühm, DVA 2019
Zeitschrift Wohnung + Gesundheit, Deutschland https://baubiologie-magazin.de
Zeitschrift IBO magazin, Österreich https://www.ibo.at/wissensverbreitung/ibomagazin-online/
Zeitschrift Baubio, Schweiz http://www.baubio.ch/baubiologie/baubiologie-journal/

Responsible for Module:
Prof. Dr.-Ing. Werner Lang sekretariat.enpb.bgu@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

BGU62062: TUM.city | TUM.stadt

Version of module description: Gültig ab summerterm 2021

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's examination consists of an exam (90 minutes) and a voluntary mid-term performance in the form of a scientific work. With the written exam, students demonstrate that they are able to reflect the theoretical knowledge on City & Water, understand the interdisciplinary interactions and are able to evaluate them in practice.

The scientific work consists of a written paper (approx. 12 pages) and a final presentation. The students work on a chosen topic in the area of City and Water in greater depth. Here, the students show that the interdisciplinary aspects of a healthy city have been understood and how these can be analysed, interpreted and applied. With the oral presentation of the scientific paper the contents and results are presented.

The grade of the scientific paper can be credited with 33% of the overall grade if the exam is passed to improve the grade.

Repeat Examination:

(Recommended) Prerequisites:
Participation in the lecture TUM.stadt.

Content:
The course is based on the contents of the lecture.
What ecological, economic and social challenges do cities face with regard to climate change and redensification?
How can interdisciplinary approaches to solutions be developed?
What are the interfaces/encounters from the different disciplines on the topic of "City & Water"?

These and other questions are aimed at the core areas of a liveable city and this requires the interdisciplinary collaboration of
planners, engineers, natural scientists, social scientists, economists and life scientists.

The following contents will be dealt with in the lecture and seminar:
- Identification of the networking of engineers, architects, natural scientists, social scientists, economists and life scientists.
- Exploration of new, interdisciplinary basic knowledge
- Exploration of interfaces/synergies and contradictions on the topic of the city through different disciplines.
- Identification, analysis and, if necessary, further development of relevant urban systems
- Impulses for the transformation of our living environments
- Development of new research questions
- Development of new interdisciplinary approaches to solutions
- Practice of working together across disciplines

The contents and topics are taught in the form of lectures, which are deepened in the seminar through interdisciplinary collabaration practice and guidance of the experts.
Graphics, pictures, short films or other suitable forms are used to illustrate the topics. In addition, interesting articles and literature recommendations
are made available for download via Moodle.

Intended Learning Outcomes:
After successful participation in the course, students are able to evaluate the subject-related and interdisciplinary interactions (synergies, potentials, contradictions) with regard to city and e.g. well-being, water or mobility.

Teaching and Learning Methods:
The seminar builds on the lecture TUM.stadt. Experts from interdisciplinary fields are involved in the lecture series.
The teaching content of the lecture is conveyed through tandem lectures. These lectures are intended to sensitise students
to the topic of "City & Water", encourage them to discuss the content and give them insights into the subject area from different
specialist perspectives. The subsequent seminar is supervised by the assistants from the previous lecture and the initiators of TUM.stadt.
The students will be sensitised to the topic of "encounter city" through group work, on-site visits, etc., in order to actively and
consciously experience connections such as trees for shading, density, heat, stress,... or water as a design tool, food, medium for
leisure and health or natural hazard. Based on the knowledge gained, the students have to develop solutions in theory.

Media:
PowerPoint presentation, live feedback, blackboard work, video

Reading List:
Wang, Xiaochang C.; Fu, Guangtao (2021): Water-Wise Cities and Sustainable Water Systems: Concepts, Technologies, and Applications: IWA Publishing.
Grant, Gary (2016): The Water Sensitive City. Chichester, UK: John Wiley & Sons, Ltd.
Haass, Heiner (2010): StadtWasser. Wasserkonzepte in der Stadtplanung. Stuttgart: Fraunhofer-IRB-Verl. (StadtGestaltung).
Russell, James S.: The Agile City. Building Well-being and Wealth in an Era of Climate Change. Washington DC, 2011.
Bott, H., Grassl, G.C., & Anders, S. (2014). Nachhaltige Stadtplanung: Konzepte für nachhaltige Quartiere. [München]: Detail.
Ekardt, F. (2016). Theorie der Nachhaltigkeit: Ethische, rechtliche, politische und transformative Zugänge - am Beispiel von Klimawandel, Ressourcenknappheit und Welthandel (2., vollständig überarbeitete und aktualisierte Auflage). Baden-Baden: Nomos.
Friedman, T. L. (2009). Hot, flat, and crowded: Why we need a green revolution--and how it can renew America (Release 2.0, updated and expanded ; 1st Picador ed.). New York: Picador/Farrar, Straus and Giroux.
Meadows, D. H., Meadows, D. L., & Randers, J. (1992). [Hauptband] (6. Aufl.). Die neuen Grenzen des Wachstums: die Lage der Menschheit: Bedrohung und Zukunftschancen / Donella H. Meadows: A. Stuttgart: Dt. Verl.-Anst.

Responsible for Module:
Markus Disse markus.disse@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

BGU62063: TUM.city - Lecture Series | TUM.stadt - Vorlesungsreihe

Version of module description: Gültig ab summerterm 2021

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:
By means of comprehension questions in a written exam (90 minutes), it is tested to what extent the students have acquired the theoretical
basic knowledge of "City & Water", understand the interdisciplinary interactions and evaluate these in action.
Answering the questions requires the students to formulate their own answers. The content taught in the lecture course is tested under
time pressure and without aids.

Repeat Examination:

(Recommended) Prerequisites:
none

Content:
What ecological, economic and social challenges do cities face with regard to climate change and redensification?
How can interdisciplinary approaches to solutions be developed?
What are the interfaces/encounters from the different disciplines on the topic of "City & Water"?

These and other questions are aimed at the core areas of a liveable city and this requires the interdisciplinary networking of planners, engineers, natural scientists, social scientists, economists and life scientists.

The following contents will be dealt with in the course:
- Identification of the networking of engineers, architects, natural scientists, social scientists, economists and life scientists.

- Exploration of new, interdisciplinary basic knowledge
- Exploration of interfaces/synergies and contradictions on the topic of the city through different disciplines. Disciplines
- Identification, analysis and, if necessary, further development of relevant urban systems
- Impulses for the transformation of our living environments
- Development of new research questions
- Development of new, theoretical approaches to solutions

In the course of the lecture, representatives from various disciplines will present and discuss the following topics on the main theme
of "City & Water":
- Urban River Restoration
- Urban Green Infrastructure
- Climate Change
- Flood Resilience
- Sponge-City
- Real Estate
- Urban Agriculture
- Urban Water Management
- Water Rights– Water Governance
- Water Quality in Megacities
- Blue-Green Cities in Germany

Within the specific topics, the following general topics are also addressed:
- City
- Landscape
- Sociology
- Regional Planning
- Health
- Water/Wastewater
- Pollutants
- Energy
- Economics
- Law
- Climate Change
- Natural Hazards
- Ecology

The contents and topics are taught in the form of lectures. Graphics, pictures and short films are used to illustrate the topics.
In addition, interesting articles and literature recommendations are made available for download via Moodle.

Intended Learning Outcomes:
After successful participation in the module, the students are able to evaluate the subject-related and interdisciplinary
interactions (synergies, potentials, contradictions) with regard to focal topic "City & Water".

Teaching and Learning Methods:
The module consists of a lecture series.
Experts from interdisciplinary subject areas are involved in the lecture series. The teaching content of the lecture is conveyed
through tandem lectures. These lectures are intended to sensitise students to the main topic "City & Water", to encourage them to discuss the content
and to give them insights into the subject area from different specialist perspectives.

Media:
PowerPoint presentation, live feedback, blackboard work, video or appropriate on-line media.

Reading List:
Wang, Xiaochang C.; Fu, Guangtao (2021): Water-Wise Cities and Sustainable Water Systems: Concepts, Technologies, and Applications: IWA Publishing.
Grant, Gary (2016): The Water Sensitive City. Chichester, UK: John Wiley & Sons, Ltd.
Haass, Heiner (2010): StadtWasser. Wasserkonzepte in der Stadtplanung. Stuttgart: Fraunhofer-IRB-Verl. (StadtGestaltung).
Russell, James S.: The Agile City. Building Well-being and Wealth in an Era of Climate Change. Washington DC, 2011.
Bott, H., Grassl, G.C., & Anders, S. (2014). Nachhaltige Stadtplanung: Konzepte für nachhaltige Quartiere. [München]: Detail.
Ekardt, F. (2016). Theorie der Nachhaltigkeit: Ethische, rechtliche, politische und transformative Zugänge - am Beispiel von Klimawandel, Ressourcenknappheit und Welthandel (2., vollständig überarbeitete und aktualisierte Auflage). Baden-Baden: Nomos.
Friedman, T. L. (2009). Hot, flat, and crowded: Why we need a green revolution--and how it can renew America (Release 2.0, updated and expanded ; 1st Picador ed.). New York: Picador/Farrar, Straus and Giroux.
Meadows, D. H., Meadows, D. L., & Randers, J. (1992). [Hauptband] (6. Aufl.). Die neuen Grenzen des Wachstums: die Lage der Menschheit: Bedrohung und Zukunftschancen / Donella H. Meadows: A. Stuttgart: Dt. Verl.-Anst.

Responsible for Module:
Markus Disse markus.disse@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

BV000075: Real Estate Management I | Immobilienmanagement I

Version of module description: Gültig ab summerterm 2020

Module Level: Bachelor/Master	**Language:** German	**Duration:** one semester	**Frequency:** winter 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:
Die Modulleistung wird in Form einer mündlichen Prüfung erbracht. In dieser soll nachgewiesen werden, dass die Grundprinzipien und Zusammenhänge in der Immobilienwirtschaft verstanden und die Methoden der Investorenrechnung, der Projektsteuerung, des Facility Managements und des Portfoliomanagements bewertet werden können.

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

Repeat Examination:

(Recommended) Prerequisites:
keine

Content:
In der Vorlesung erfolgt eine Einführung in den Immobilienbereich mit folgenden Themen:
- Rechtliche Grundlagen
- Nutzungstypen von Immobilien
- Wertermittlungsverfahren
- Investorenrechnung
- Projektentwicklung / Projektsteuerung
- Facility Management

- Aktives Portfoliomanagement

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage, die Grundprinzipien in der Immobilienwirtschaft einschließlich der Zusammenhänge zwischen Nutzungsart und Lagekriterien zu verstehen. Weiterhin sind die Studierenden in der Lage, Methoden der Investorenrechnung, der Projektsteuerung, des Facility Managements und des Portfoliomanagements zu veranschaulichen.

Teaching and Learning Methods:
Als Lehrformat werden Vorlesungen abgehalten. Darin kommen die Lehrmethoden Vorträge und Präsentationen zur Anwendung, Diese dienen dazu, den Studierenden das Verständnis für die Grundprinzipien und Methoden des Immobilienmanagements verständlich zu machen. Die Studierenden profitieren dabei von der beruflichen Erfahrung des Dozenten und illustrierten Praxisbeispielen. Die Lehrmethoden sind auf die Lernaktivitäten Materialrecherche, Studium von Literatur und Auswendiglernen ausgerichtet.

Media:
Präsentationsfolien und -dokumente

Reading List:

Responsible for Module:
Florian Siegert (florian.siegert@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Immobilienmanagement 1 (Vorlesung, 2 SWS)
Stützer H (Bendzko T)
For further information in this module, please click campus.tum.de or here.

Module Description

BV000082: Financing of Real Estate | Immobilienfinanzierung [ImmoFin]

Version of module description: Gültig ab summerterm 2019

Module Level: Master	**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:
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:

(Recommended) Prerequisites:
none

Content:
Definitions and Basics of Real Estate Finance; Types of Loans; Securing a Loan; Funding; Bond System; Financial Risk; Real Estate Structured Finance; Securitization; Real Estate Investment Trusts

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. 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:
Detailed lecture notes

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

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

Module Description

BV130003: Reinvigorating existing buildings | Redevelopment von Bestandsimmobilien [Redev]

Version of module description: Gültig ab summerterm 2019

Module Level: Master	**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:
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:

(Recommended) Prerequisites:
none

Content:
Sustainable Concepts, Classification of Buildings, Lifecycle, Utilisation Concepts, Conversion Concepts, construction during operation, inner-city construction management, stakeholder anaysis, Logistic Concepts, Quality Management

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. 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:
Detailed lecture notes

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

Courses (Type of course, Weekly hours per semester), Instructor:
Redevelopment von Bestandsimmobilien (Vorlesung, 2 SWS)
Zimmermann J
For further information in this module, please click campus.tum.de or here.

Module Description

BV550009: Advanced Management of Business Processes in Construction | Projekt- und Unternehmensprozesse in der Bauwirtschaft [Prj&UntProz_BAu]

Version of module description: Gültig ab winterterm 2011/12

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

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

Description of Examination Method:
The examination consists of a test 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:
Turn Key Building, Construction and Infrastructure Projects:
Turnkey Building and Specification, Shifting of Planning Responsibilities; Types of Contracts; General Contractor, Structuring of Projects, Planning Processes in Turn Key Building; Risk Management; Guarantees and Insurances; Quotation Processing; Contract Negotiations; Project Management;Change Management; Scheduling of incoming and outgoing payments; Documentation;Closing a Project; Warranty

Management of Business Processes:
Business Processes; Organisational Structure; Market development and Acquisition; Risk Management; Legal Project Management; Human Resources Management; Financial Accounting, Cost Accounting; Purchasing; Corporate Management; Corporate Planning; Balanced Scorecard; Strategic Corporate Governance.

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:
Prof. Dr. Konrad Nübel (konrad.nuebel@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Schlüsselfertiger Hoch- und Ingenieurbau (Vorlesung mit integrierten Übungen, 2 SWS)
Nübel K [L], Nübel K

Geschäftsprozessmanagement in der Bauwirtschaft (Vorlesung mit integrierten Übungen, 2 SWS)
Nübel K [L], Nübel K
For further information in this module, please click campus.tum.de or here.

Module Description

BV550010: Seminar Entrepreneurship in Construction | Seminar Unternehmeringenieur in der Bauwirtschaft [SemUI_BW]

Version of module description: Gültig ab winterterm 2011/12

Module Level: Master	**Language:** German	**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 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.
Furthermore, a scientific midterm-elaboration will count 25% of the total grade.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Module Advanced Management of Business Processes in Construction (BV550009)

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

Exemplary subjects:
e.g. Comparison of Building Contract Models (VOB, NEC, FIDIC); Impact of Globalization on the Selection of Standardized Contract Conditions; Optimization Potential of International Project Organization; Partnering in Construction Management; Competence Competitions in Partnering Models; Optimization Potential of Functional Descriptions; Controlling of Modifications of Design on web-based Platforms; Impact of the Project Organization on Key Performance Indicators for Planning; Construction Economy as Service – Competition of Performance or Products; Incom-

patible Goals of Principal and Agent; Theoretical Models of Cooperation and their Impact on Execution of Construction Projects.

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:
Recent scientific literature, power point-presentations, partially use of black/whiteboard, videoclips, excursions

Reading List:
Recent scientific Literatur regarding the actual subjects

Responsible for Module:
Prof. Dr. Konrad Nübel (konrad.nuebel@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Seminar Unternehmeringenieur (Seminar, 2 SWS)
Nübel K
For further information in this module, please click campus.tum.de or here.

Module Description

BV620003: Interaction between Sustainability and Building Culture | Wechselwirkungen zwischen Nachhaltigkeit und Baukultur

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
The examination is the supervised preparation of a scientific paper (approx. 20 pages) in teams of 2-3 students, which has to be uploaded on Moodle.
By analysing sample projects within their chosen topic, the students demonstrate that they are fully familiar with the criteria of sustainability and building culture. The subsequent examination of the interactions, such as synergies and conflicts between sustainability and building culture, shows the ability of an in-depth, structured examination of their diverse and sometimes conflicting requirements.
The students demonstrate their competence in assessing the implementation of building culture aspects and sustainability requirements by means of a differentiated argumentative presentation.
At the end of the semester, the scientific elaboration will be presented in a presentation (20 min.) to test the communicative competence of the presentation of scientific studies and the resulting lines of argumentation.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Participants should have gained initial experience in designing or executing construction projects as part of their studies. Students should be familiar with the contents of the lecture "Fundamentals of Sustainable Building".

Content:
Contents:
- History of sustainability in construction

- Assessment criteria for sustainability
- What is building culture? Evaluation criteria of building culture and architectural-spatial quality
- Mutual influence of sustainability and building culture
- Sustainability in the building industry of other cultures (e.g. influence of climate or local factors on building forms)
- Analysis of the current situation in Europe (e.g. competition results with the topic sustainability, built example projects)
- Motives for using sustainability as a design criterion (e.g. the PR effectiveness of "green")
- "Nimby" - not in my backyard: Sustainability in practice
- Bringing strategies, sustainability and building culture into harmony

Intended Learning Outcomes:
After attending the module, students are able to
- to discuss the importance of sustainability as a design criterion
- to recognise the responsibility of the planning disciplines for the quality of the buildings and to describe the possibilities of planning influence in the context of integral planning
- to understand the development of the identity of traditional and vernacular building cultures from technical and climatic requirements of a country or region
- explain criteria for the assessment of building culture and apply them to examples of projects
- to implement sustainability aspects in the design process, taking into account the impact on building culture
- to investigate conflicts of objectives and synergies between building culture and sustainability
- to analyse the connection between the requirements of sustainability and their effects on building culture in building and civil engineering projects and to assess the project from these aspects

Teaching and Learning Methods:
The module consists of a lecture and a seminar.
The lecture creates the content basics by imparting theoretical knowledge and giving insights into current developments. Specialist experts complement the lecture as guest speakers to illustrate the practical relevance and application. By representing different perspectives on the requirements of sustainability and building culture, the lectures encourage students to reflect on the topic in subsequent discussions.
Excursions are used to deepen and illustrate the contents of the lectures.

In the seminar, the topics are dealt with in greater depth and a detailed examination of individual questions is allowed. Aspects of the topic will be developed in workshops and discussions at the beginning.
In teams of 2-3 students the critical examination of the interactions between building culture and sustainability (e.g. conflicts of objectives and synergies) will be deepened in the course of the semester. For this purpose, topics are selected (e.g. specific building typologies or projects). On the basis of these, students apply the acquired specialist knowledge by examining and assessing projects in the selected topic area with regard to the interactions.

The result is prepared in the form of a written, scientific paper and presented in a seminar presentation.

Media:
Powerpoint, moderation cards (workshop work), blog

Reading List:
- Durth, W., Sigel, P., Baukultur - Spiegel gesellschaftlichen Wandels, Jovis Verlag, Berlin, 2009
- Weeber, H., Weeber, R., Baukultur! Bundesministerium für Verkehr, Bau und Stadtentwicklung, Berlin, 2007
- Bundesstiftung Baukultur, Nagel, R. (Hrsg.), Baukulturbericht 2014/15, Gebaute Lebensräume der Zukunft – Fokus Stadt Potsdam, 2014

Responsible for Module:
Prof.Werner Lang sekretariat.enpb.bgu@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Wechselwirkungen zwischen Nachhaltigkeit und Baukultur - Vorlesung (Vorlesung, 2 SWS)
Lang W [L], Koth S, Schwering K

Wechselwirkungen zwischen Nachhaltigkeit und Baukultur - Seminar (Seminar, 2 SWS)
Lang W [L], Koth S, Schwering K
For further information in this module, please click campus.tum.de or here.

Module Description

BV620006: Special Topics in Sustainable Design | Sonderthemen des nachhaltigen Bauens

Version of module description: Gültig ab winterterm 2018/19

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

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

Description of Examination Method:
Lecture with preparation and follow-up of the lecture contents. Independent development of strategies and approaches to solutions, which are presented at the end of the semester in the form of a scientific paper and a presentation. The examination in the form of a presentation and a scientific paper is intended to demonstrate that students are able to deal with current research topics over a period of one semester and to critically examine them. In the process, various questions from the fields of building physics, architecture and technical building equipment are addressed and applied and evaluated in a research-related manner.
In interaction with the examiners, typical problems are to be analysed in a result-oriented way and the possible solutions are to be brought into a meaningful context.
The form of the oral assessment allows for iterative questions of increasing complexity and the individual approach to the students, which enables a realistic assessment of the competences acquired in the module.

Repeat Examination:

(Recommended) Prerequisites:
Grundkenntnisse in der Architektur/Bauphysik/Gebäudetechnik

Content:
As drivers of science and research, universities are continually expanding their ties with the business world. The ring lectures, which take place at regular intervals, give students insight into practical work experience. The lecturers will both share experience from their companies and be available for discussions on topics from the public sector and other fields of research. In collaboration with the Oskar von Miller Forum.

Intended Learning Outcomes:
Connect students to current issues from the real world. Provide insight into topical discussions from a group of themes and establish contact with companies.

Teaching and Learning Methods:
The course takes the form of a classic lecture, followed by discussions between the students and experts from research and business. Students participating in the lecture select one topic/ object each from the following teaching content at the beginning of the semester, which is to be researched intensively throughout the semester. At the end of the semester, the result is outlined in a short presentation.

Media:
lecture notes, data projector presentation

Reading List:
Hegger, Manfred ; Fuchs, Matthias ; Stark, Thomas ; Zeumer, Martin: Energie Atlas : Nachhaltige Architektur. Berlin: Walter de Gruyter, 2007.
Kaltschmitt, Martin ; Streicher, Wolfgang ; Wiese, Andreas: Erneuerbare Energien : Systemtechnik, Wirtschaftlichkeit, Umweltaspekte. Berlin Heidelberg New York: Springer-Verlag, 2013.
Lenz, Bernhard ; Schreiber, Jürgen ; Stark, Thomas: Nachhaltige Gebäudetechnik : Grundlagen - Systeme - Konzepte. Berlin: Walter de Gruyter, 2010.

Responsible for Module:
Prof. Werner Lang sekretariat.enpb.bgu@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

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

Version of module description: Gültig ab summerterm 2021

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

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:
-

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

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

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

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

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

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

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

Responsible for Module:
Magnus Fröhling

Courses (Type of course, Weekly hours per semester), Instructor:
Advanced Seminar Circular Economy for a Sustainable Society: From Theory to Practice (Seminar, 4 SWS)
Fröhling M [L], Fröhling M, Heinrich V
For further information in this module, please click campus.tum.de or here.

Module Description

ED100003: Soft Skills for Studies and Career | Schlüsselkompetenzen für Studium und Beruf

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/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:
Die Modulprüfung erfolgt als Übungsleistung (Studienleistung) mit dem Ziel der Anwendung der erlernten Kompetenzen zur Lösung anwendungsbezogener Probleme oder Situationen aus dem Arbeits- und Universitätsleben. Diese werden durch die aktive Teilnahme an den Seminaren und der Bearbeitung von Übungsleistungen zu den drei Kompetenzbereichen (Selbst-, Sozial- und Methodenkompetenz) überprüft.
Durch das Bearbeiten der Übungsleistungen sollen die Studierenden demonstrieren, dass sie die vorgegebenen Qualifikationsziele in den Seminaren (Identifikation der individuellen Haltung zu arbeitsrelevanten Themenbereichen, Reflexion differierender Meinungen, Beurteilung von Aufgaben und Problemen zur Umsetzung von Lösungsstrategien) erreicht haben. Diese Aufgaben umfassen schriftliche Einzelaufgaben zur Reflexion oder Anwendung, Lehrgespräche und Diskussionen sowie Anwendungsaufgaben allein oder in Gruppen. Unter Anwendungsaufgaben fallen unter anderem (Kurz-)Präsentationen, Problemlöseaufgaben, Übungen oder schriftliche Aufgaben im Rahmen von eLearnings.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Interesse zum angebotenen Soft Skills Themenbereiche und zur individuellen Auseinandersetzung mit dem Schwerpunkt.

Content:
Im Seminar erhalten die Studierenden Einblick in berufs- und studiumsrelevante Themen. Der Fokus der Inhalte steht dabei in engem Zusammenhang mit dem Schwerpunkt des Seminars.
Themenspektrum der Seminare:

Verantwortung tragen, Persönlichkeit stärken, Interaktion fördern, Vielfalt nutzen, Wissen managen, Zukunft gestalten. Neben theoretischen Inputs zu den jeweiligen Themen steht die interaktive Anwendung und Bearbeitung des Themas im Mittelpunkt. Die Reflexion des eigenen Verhaltens in Einzel- und Gruppensituationen wird angeregt. Darüber hinaus erlernen und trainieren die Teilnehmer konkrete Verhaltensweisen in sozialen Situationen und erhalten Feedback.

Intended Learning Outcomes:
Folgende Learning-Outcomes sind nach dem erfolgreichen Absolvieren des Moduls gegeben:
- Im Bereich der Selbstkompetenz kennen und verstehen die Studierenden ihren eigenen Arbeitsstil sowie Ihre Ziele, Werte und Handlungsmuster. Sie identifizieren ihre individuelle Haltung zu arbeitsrelevanten Themenbereichen und verstehen die Beweggründe und Konsequenzen ihres Handelns. Die Studierenden übertragen die erlernten Inhalte auf ihren Lebensalltag und beurteilen eigenständig ihre Arbeitsweise und ihr Vorgehen zum Setzen von Prioritäten.
- Im Bereich der Sozialkompetenz kennen und verstehen die Studierenden Modelle und Theorien zur situationsangemessenen Interaktion mit anderen Menschen. Sie können differierende Meinungen erkennen und konstruktives Kommunikationsverhalten umsetzen. Sie beurteilen soziale Situationen und wenden das erlernte Verhalten flexibel an.
- Im Bereich der Methodenkompetenz können die Studierenden Aufgaben und Probleme aufgrund einer sinnvollen Planung und Umsetzung von Lösungsstrategien adäquat erkennen und verstehen. Sie sind in der Lage, Ziele zu erkennen und die gewählte Strategie zielgruppenspezifisch zu vermitteln. Die Lernenden können konkrete Techniken des Präsentierens oder Moderierens anwenden und deren Eignung für die Situation bewerten.

Teaching and Learning Methods:
Innerhalb des Lehrformats kommen verschiedene Lehrmethoden zum Einsatz. Je nach Lehrveranstaltung können die Studierenden an einem Präsenz-Seminar oder an einem Hybrid-Seminar aktiv teilnehmen. Beides bietet die Möglichkeit, verschiedene Lehr- und Lernmethoden zu mischen und somit eine optimale Vorbereitung für die Studierenden zu ermöglichen. Der Methodenmix aus Wissensvermittlung (durch vortragende fundierte Modelle), Bearbeitungen und Diskussionen in Kleingruppenarbeit und der Anwendung von eigenen Beispielen im Rahmen von begleitenden Gruppenübungen wie Problemlöseaufgaben, Fallanalysen oder Simulationen lassen die Studierenden die Themen verinnerlichen und handlungsorientiert anwenden. In der anschließenden Reflexion oder Diskussion wird das Erlebte zusammen mit den Studierenden analysiert und bewertet und so das erfahrungsorientierte Lernen abgerundet.

Media:
Vortrag, Präsentation, interaktive Gesprächsführung über Flipchart, Whiteboard und Pinnwand, Online-Lehrmaterialien

Reading List:
Literaturhinweise erhalten die Studierenden im Seminar sowie im Moodlekurs

Responsible for Module:
Theisen, Birgit; Dr. phil.

Courses (Type of course, Weekly hours per semester), Instructor:
Unternehmenskultur - Wissen, was zu mir passt (ZSK) (Seminar, 1 SWS)
Aepfelbacher M [L], Aepfelbacher M, Glasl F

Emotionale Intelligenz - Emotionen wahrnehmen, verstehen und steuern (ZSK) (Seminar, 1 SWS)
Aepfelbacher M [L], Aepfelbacher M, Poetzsch L

Professionell Präsentieren- so bleiben Sie in Erinnerung (ZSK) (Seminar, 1 SWS)
Ostermeier B [L], Aepfelbacher M, Ostermeier B

Souverän Argumentieren und Verhandeln - Bessere Ergebnisse erzielen (ZSK) (Seminar, 1 SWS)
Poetzsch L [L], Poetzsch L

Erfolgsfaktor Storytelling - Die Macht guter Geschichten (ZSK) (Seminar, 1 SWS)
Poetzsch L [L], Poetzsch L

Kreativitätstechniken - So finden Sie schnell innovative Lösungen (ZSK) (Seminar, 1 SWS)
Poetzsch L [L], Poetzsch L

Nachhaltiges Besprechungsmanagement (ZSK) (Seminar, 1 SWS)
Theisen B [L], Theisen B, ZSK H

Mit Motivation zum persönlichen Erfolg (ZSK) (Seminar, 1 SWS)
Zauner A [L], Zauner A

Kommunikationstraining - auch in stressigen Situationen souverän bleiben (ZSK) (Seminar, 1 SWS)
Zauner A [L], Zauner A, ZSK H
For further information in this module, please click campus.tum.de or here.

Module Description

ED100004: Soft Skills for Studies and Career | Schlüsselkompetenzen für Studium und Beruf

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	**Language:** German/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:
Die Modulprüfung erfolgt als Übungsleistung (Studienleistung) mit dem Ziel der Anwendung der erlernten Kompetenzen zur Lösung anwendungsbezogener Probleme oder Situationen aus dem Arbeits- und Universitätsleben. Diese werden durch die aktive Teilnahme an den Seminaren und der Bearbeitung von Übungsleistungen zu den drei Kompetenzbereichen (Selbst-, Sozial- und Methodenkompetenz) überprüft.
Durch das Bearbeiten der Übungsleistungen sollen die Studierenden demonstrieren, dass sie die vorgegebenen Qualifikationsziele in den Seminaren (Identifikation der individuellen Haltung zu arbeitsrelevanten Themenbereichen, Reflexion differierender Meinungen, Beurteilung von Aufgaben und Problemen zur Umsetzung von Lösungsstrategien) erreicht haben. Diese Aufgaben umfassen schriftliche Einzelaufgaben zur Reflexion oder Anwendung, Lehrgespräche und Diskussionen sowie Anwendungsaufgaben allein oder in Gruppen. Unter Anwendungsaufgaben fallen unter anderem (Kurz-)Präsentationen, Problemlöseaufgaben, Übungen oder schriftliche Aufgaben im Rahmen von eLearnings.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Interesse zum angebotenen Soft Skills Themenbereiche und zur individuellen Auseinandersetzung mit dem Schwerpunkt.

Content:
Im Seminar erhalten die Studierenden Einblick in berufs- und studiumsrelevante Themen. Der Fokus der Inhalte steht dabei in engem Zusammenhang mit dem Schwerpunkt des Seminars.
Themenspektrum der Seminare:

Verantwortung tragen, Persönlichkeit stärken, Interaktion fördern, Vielfalt nutzen, Wissen managen, Zukunft gestalten. Neben theoretischen Inputs zu den jeweiligen Themen steht die interaktive Anwendung und Bearbeitung des Themas im Mittelpunkt. Die Reflexion des eigenen Verhaltens in Einzel- und Gruppensituationen wird angeregt. Darüber hinaus erlernen und trainieren die Teilnehmer konkrete Verhaltensweisen in sozialen Situationen und erhalten Feedback.

Intended Learning Outcomes:
Folgende Learning-Outcomes sind nach dem erfolgreichen Absolvieren des Moduls gegeben:
- Im Bereich der Selbstkompetenz kennen und verstehen die Studierenden ihren eigenen Arbeitsstil sowie Ihre Ziele, Werte und Handlungsmuster. Sie identifizieren ihre individuelle Haltung zu arbeitsrelevanten Themenbereichen und verstehen und analysieren die Beweggründe und Konsequenzen ihres Handelns. Die Studierenden übertragen die erlernten Inhalte auf ihren Lebensalltag und beurteilen eigenständig ihre Arbeitsweise und ihr Vorgehen zum Setzen von Prioritäten.
- Im Bereich der Sozialkompetenz kennen und verstehen die Studierenden Modelle und Theorien zur situationsangemessenen Interaktion mit anderen Menschen. Sie können differierende Meinungen reflektieren und entwickeln ein konstruktives Kommunikationsverhalten. Sie beurteilen soziale Situationen und wenden das erlernte Verhalten flexibel an.
- Im Bereich der Methodenkompetenz können die Studierenden Aufgaben und Probleme aufgrund einer sinnvollen Planung und Umsetzung von Lösungsstrategien adäquat erkennen, verstehen und beurteilen. Sie sind in der Lage, Ziele zu analysieren und die gewählte Strategie zielgruppenspezifisch zu vermitteln. Die Lernenden können konkrete Techniken des Präsentierens oder Moderierens anwenden und deren Eignung für die Situation bewerten.

Teaching and Learning Methods:
Innerhalb des Lehrformats kommen verschiedene Lehrmethoden zum Einsatz. Je nach Lehrveranstaltung können die Studierenden an einem Präsenz-Seminar oder an einem Hybrid-Seminar aktiv teilnehmen. Beides bietet die Möglichkeit, verschiedene Lehr- und Lernmethoden zu mischen und somit eine optimale Vorbereitung für die Studierenden zu ermöglichen. Der Methodenmix aus Wissensvermittlung (durch vortragende fundierte Modelle), Bearbeitungen und Diskussionen in Kleingruppenarbeit und der Anwendung von eigenen Beispielen im Rahmen von begleitenden Gruppenübungen wie Problemlöseaufgaben, Fallanalysen oder Simulationen lassen die Studierenden die Themen verinnerlichen und handlungsorientiert anwenden. In der anschließenden Reflexion oder Diskussion wird das Erlebte zusammen mit den Studierenden analysiert und bewertet und so das erfahrungsorientierte Lernen abgerundet.

Media:
Vortrag, Präsentation, interaktive Gesprächsführung über Flipchart, Whiteboard und Pinnwand, Online-Lehrmaterialien

Reading List:
Literaturhinweise erhalten die Studierenden im Seminar sowie im Moodlekurs

Responsible for Module:
Theisen, Birgit; Dr. phil.

Courses (Type of course, Weekly hours per semester), Instructor:
Unternehmenskultur - Wissen, was zu mir passt (ZSK) (Seminar, 1 SWS)
Aepfelbacher M [L], Aepfelbacher M, Glasl F

Emotionale Intelligenz - Emotionen wahrnehmen, verstehen und steuern (ZSK) (Seminar, 1 SWS)
Aepfelbacher M [L], Aepfelbacher M, Poetzsch L

Erfolgreich im Team – Persönliche Teamfähigkeit stärken (ZSK) (Seminar, 2 SWS)
Glasl F [L], Aepfelbacher M, Glasl F

Professionell Präsentieren- so bleiben Sie in Erinnerung (ZSK) (Seminar, 1 SWS)
Ostermeier B [L], Aepfelbacher M, Ostermeier B

Agil oder klassisch?- Projektmanagement sinnvoll einsetzen (ZSK) (Seminar, 4 SWS)
Poetzsch L [L], Aepfelbacher M, Poetzsch L

Ihre Stärken überzeugen - Das eigene Potential erkennen und nutzen (ZSK) (Seminar, 2 SWS)
Poetzsch L [L], Aepfelbacher M, Poetzsch L

Souverän Argumentieren und Verhandeln - Bessere Ergebnisse erzielen (ZSK) (Seminar, 1 SWS)
Poetzsch L [L], Poetzsch L

Erfolgsfaktor Storytelling - Die Macht guter Geschichten (ZSK) (Seminar, 1 SWS)
Poetzsch L [L], Poetzsch L

Kreativitätstechniken - So finden Sie schnell innovative Lösungen (ZSK) (Seminar, 1 SWS)
Poetzsch L [L], Poetzsch L

Strukturiert durch das Semester - Ihr Plan für ein besseres Selbstmanagement (ZSK) (Seminar, 2 SWS)
Poetzsch L [L], Poetzsch L, Zauner A

Nachhaltiges Besprechungsmanagement (ZSK) (Seminar, 1 SWS)
Theisen B [L], Theisen B, ZSK H

Überzeugende Rhetorik - Souverän auftreten und begeistern (ZSK) (Seminar, 2 SWS)
Zauner A [L], Poetzsch L, Zauner A

Wirksame Kommunikation – Konflikte mindern und die eigene Gesprächskompetenz erweitern (ZSK) (Seminar, 2 SWS)
Zauner A [L], Zauner A

Mit Motivation zum persönlichen Erfolg (ZSK) (Seminar, 1 SWS)
Zauner A [L], Zauner A

Kommunikationstraining - auch in stressigen Situationen souverän bleiben (ZSK) (Seminar, 1 SWS)
Zauner A [L], Zauner A, ZSK H
For further information in this module, please click campus.tum.de or here.

Module Description

ED100005: Soft Skills for Studies and Career | Schlüsselkompetenzen für Studium und Beruf

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/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:
Die Modulprüfung erfolgt als Übungsleistung (Studienleistung) mit dem Ziel der Anwendung der erlernten Kompetenzen zur Lösung anwendungsbezogener Probleme oder Situationen aus dem Arbeits- und Universitätsleben. Diese werden durch die aktive Teilnahme an den Seminaren und der Bearbeitung von Übungsleistungen zu den drei Kompetenzbereichen (Selbst-, Sozial- und Methodenkompetenz) überprüft.
Durch das Bearbeiten der Übungsleistungen sollen die Studierenden demonstrieren, dass sie die vorgegebenen Qualifikationsziele in den Seminaren (Identifikation der individuellen Haltung zu arbeitsrelevanten Themenbereichen, Reflexion differierender Meinungen, Beurteilung von Aufgaben und Problemen zur Umsetzung von Lösungsstrategien) erreicht haben. Diese Aufgaben umfassen schriftliche Einzelaufgaben zur Reflexion oder Anwendung, Lehrgespräche und Diskussionen sowie Anwendungsaufgaben allein oder in Gruppen. Unter Anwendungsaufgaben fallen unter anderem (Kurz-)Präsentationen, Problemlöseaufgaben, Übungen oder schriftliche Aufgaben im Rahmen von eLearnings.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Interesse zum angebotenen Soft Skills Themenbereiche und zur individuellen Auseinandersetzung mit dem Schwerpunkt.

Content:
Im Seminar erhalten die Studierenden Einblick in berufs- und studiumsrelevante Themen. Der Fokus der Inhalte steht dabei in engem Zusammenhang mit dem Schwerpunkt des Seminars.
Themenspektrum der Seminare:

Verantwortung tragen, Persönlichkeit stärken, Interaktion fördern, Vielfalt nutzen, Wissen managen, Zukunft gestalten. Neben theoretischen Inputs zu den jeweiligen Themen steht die interaktive Anwendung und Bearbeitung des Themas im Mittelpunkt. Die Reflexion des eigenen Verhaltens in Einzel- und Gruppensituationen wird angeregt. Darüber hinaus erlernen und trainieren die Teilnehmer konkrete Verhaltensweisen in sozialen Situationen und erhalten Feedback.

Intended Learning Outcomes:
Folgende Learning-Outcomes sind nach dem erfolgreichen Absolvieren des Moduls gegeben:
- Im Bereich der Selbstkompetenz kennen und verstehen die Studierenden ihren eigenen Arbeitsstil sowie Ihre Ziele, Werte und Handlungsmuster. Sie identifizieren ihre individuelle Haltung zu arbeitsrelevanten Themenbereichen und analysieren und bewerten die Beweggründe und Konsequenzen ihres Handelns. Die Studierenden übertragen die erlernten Inhalte auf ihren Lebensalltag und bewerten eigenständig ihre Arbeitsweise und entwickeln ihr Vorgehen zum Setzen von Prioritäten.
- Im Bereich der Sozialkompetenz verstehen und analysieren die Studierenden Modelle und Theorien zur situationsangemessenen Interaktion mit anderen Menschen. Sie können differierende Meinungen reflektieren und entwickeln ein konstruktives Kommunikationsverhalten. Sie beurteilen soziale Situationen und wenden das erlernte Verhalten flexibel an.
- Im Bereich der Methodenkompetenz können die Studierenden Aufgaben und Probleme aufgrund einer sinnvollen Planung und Umsetzung von Lösungsstrategien adäquat anwenden, analysieren und beurteilen. Sie sind in der Lage, Ziele zu analysieren und die gewählte Strategie zielgruppenspezifisch zu vermitteln. Die Lernenden können konkrete Techniken des Präsentierens oder Moderierens bewertend anwenden und passgenaue Eignungen für die Situation entwickeln.

Teaching and Learning Methods:
Innerhalb des Lehrformats kommen verschiedene Lehrmethoden zum Einsatz. Je nach Lehrveranstaltung können die Studierenden an einem Präsenz-Seminar oder an einem Hybrid-Seminar aktiv teilnehmen. Beides bietet die Möglichkeit, verschiedene Lehr- und Lernmethoden zu mischen und somit eine optimale Vorbereitung für die Studierenden zu ermöglichen. Der Methodenmix aus Wissensvermittlung (durch vortragende fundierte Modelle), Bearbeitungen und Diskussionen in Kleingruppenarbeit und der Anwendung von eigenen Beispielen im Rahmen von begleitenden Gruppenübungen wie Problemlöseaufgaben, Fallanalysen oder Simulationen lassen die Studierenden die Themen verinnerlichen und handlungsorientiert anwenden. In der anschließenden Reflexion oder Diskussion wird das Erlebte zusammen mit den Studierenden analysiert und bewertet und so das erfahrungsorientierte Lernen abgerundet.

Media:
Vortrag, Präsentation, interaktive Gesprächsführung über Flipchart, Whiteboard und Pinnwand, Online-Lehrmaterialien

Reading List:
Literaturhinweise erhalten die Studierenden im Seminar sowie im Moodlekurs

Responsible for Module:
Theisen, Birgit; Dr. phil.

Courses (Type of course, Weekly hours per semester), Instructor:
Unternehmenskultur - Wissen, was zu mir passt (ZSK) (Seminar, 1 SWS)
Aepfelbacher M [L], Aepfelbacher M, Glasl F

Emotionale Intelligenz - Emotionen wahrnehmen, verstehen und steuern (ZSK) (Seminar, 1 SWS)
Aepfelbacher M [L], Aepfelbacher M, Poetzsch L

Erfolgreich im Team – Persönliche Teamfähigkeit stärken (ZSK) (Seminar, 2 SWS)
Glasl F [L], Aepfelbacher M, Glasl F

Professionell Präsentieren- so bleiben Sie in Erinnerung (ZSK) (Seminar, 1 SWS)
Ostermeier B [L], Aepfelbacher M, Ostermeier B

Ihre Stärken überzeugen - Das eigene Potential erkennen und nutzen (ZSK) (Seminar, 2 SWS)
Poetzsch L [L], Aepfelbacher M, Poetzsch L

Agil oder klassisch?- Projektmanagement sinnvoll einsetzen (ZSK) (Seminar, 4 SWS)
Poetzsch L [L], Aepfelbacher M, Poetzsch L

Erfolgsfaktor Storytelling - Die Macht guter Geschichten (ZSK) (Seminar, 1 SWS)
Poetzsch L [L], Poetzsch L

Kreativitätstechniken - So finden Sie schnell innovative Lösungen (ZSK) (Seminar, 1 SWS)
Poetzsch L [L], Poetzsch L

Souverän Argumentieren und Verhandeln - Bessere Ergebnisse erzielen (ZSK) (Seminar, 1 SWS)
Poetzsch L [L], Poetzsch L

Strukturiert durch das Semester - Ihr Plan für ein besseres Selbstmanagement (ZSK) (Seminar, 2 SWS)
Poetzsch L [L], Poetzsch L, Zauner A

Nachhaltiges Besprechungsmanagement (ZSK) (Seminar, 1 SWS)
Theisen B [L], Theisen B, ZSK H

Überzeugende Rhetorik - Souverän auftreten und begeistern (ZSK) (Seminar, 2 SWS)
Zauner A [L], Poetzsch L, Zauner A

Wirksame Kommunikation – Konflikte mindern und die eigene Gesprächskompetenz erweitern (ZSK) (Seminar, 2 SWS)
Zauner A [L], Zauner A

Mit Motivation zum persönlichen Erfolg (ZSK) (Seminar, 1 SWS)
Zauner A [L], Zauner A

Kommunikationstraining - auch in stressigen Situationen souverän bleiben (ZSK) (Seminar, 1 SWS)
Zauner A [L], Zauner A, ZSK H
For further information in this module, please click campus.tum.de or here.

Module Description

ED120049: Interdisciplinary Summerschool Urban Design | Interdisziplinäre Summerschool Städtebau

Version of module description: Gültig ab summerterm 2022

Module Level: Bachelor/Master	**Language:** German/English	**Duration:** one semester	**Frequency:** 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:
Die Modulprüfung ist eine Projektarbeit, die Bewertung erfolgt anhand dem im Kurs erarbeiteten Konzept für einen transformativen Eingriff im urbanen Raum. Mit dem Konzept wird die Fähigkeit nachgewiesen, städtebauliche Fragestellungen konzeptionell und in einem interdisziplinären Team bearbeiten zu können. Die Beurteilung erfolgt anhand der abgegebenen Dokumentation und der Präsentation. Anhand dieser wird geprüft, ob die Studentinnen und Studenten in der Lage sind, ihre Konzepte verständlich, präzise und anschaulich darzustellen und dabei überzeugend und professionell aufzutreten.

Repeat Examination:

(Recommended) Prerequisites:
- Basisverständnis urbaner Transformationsprozesse
- Grundkenntnisse analoger sowie digitaler Zeichnungsmethoden
- Grundkenntnisse der infrastrukturellen Organisation von Städten

Content:
Die Studierenden leiten in interdisziplinären Teams Erkenntnisse aus den Ergebnissen vorangegangener städtebaulicher Aushandlungsprozesse mit Forschungs- und/oder Praxisbezug ab. Diese werden hinsichtlich der Aspekte Nachhaltigkeit, Gerechtigkeit und weiterer Aspekte bewertet, formuliert und dienen als Ausgangslage eines Kurzentwurfs oder mehrerer Kurzentwürfe. In diesem werden räumliche, soziale und infrastrukturelle Merkmale einer spezifischen urbanen Situation analysiert und Konzepte zu deren Umgestaltung generiert, ggf. auch mit Beteiligung von Externen im Sinne eines Co-Design-Prozesses.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen sind die Studentinnen und Studenten in der Lage
- die Relevanz eines städtebaulichen Problems zu verstehen und gemeinsam im interdisziplinären Team Lösungen zu erarbeiten
- verschiedene städtebauliche Interessen zu verstehen und Aushandlungsvorschläge zu machen
- Fachdisziplinübergreifend Perspektiven zu wechseln und Projektmanagement in interdisziplinärer Teamarbeit anzuwenden
- verschiedene Methoden für die städtebauliche Analyse und Entwurf anzuwenden
- Umfang und Komplexität der Arbeit von interdisziplinären Forschungsprojekten mit hohem Partizipationsanteil zu verstehen

Teaching and Learning Methods:
- Studium und Präsentation relevanter Case-Studies
- Vermitteln von methodischem Wissen mittels Input-Vorträgen
- Kooperationsformen in interdisziplinären Reallaboren mittels Best-Practice Beispielen und Input-Vorträgen
- Arbeit in interdisziplinären Teams

Media:
- Zeichnungen (Handzeichnungen, CAD) auf verschiedenen Papierarten
- Beamerpräsentationen
- Bildliche Darstellungen (Handzeichnungen, CAD, Fotografie)
- physische Modelle

Reading List:
A. Benze, Alltagsorte in der Stadtregion: Atlas experimenteller Kartographie Taschenbuch, 2012
C. Bock, Das Kotti-Prinzip: Urbane Komplizenschaften zwischen Räumen, Menschen, Zeit, Wissen und Dingen Broschüre, 2018
J. Gehl, Cities for People, 2010
J. Gehl, How to Study Public Life: Methods in Urban Design Gebundene Ausgabe – Illustriert, 2013
J. Jacobs, The Death and Life of Great American Cities, 1962
M. Lydon & A. Garcia, Tactical Urbanism, 2015
Professur Kees Christiaanse, Die Stadt als Ressource, 2014

Responsible for Module:
Prof. Benedikt Boucsein

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

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

Module Description

ED130012: Advanced Topics in Sustainable Real Estate | Aktuelle Fragen zur nachhaltigen Immobilienwirtschaft [ATSRE]

Version of module description: Gültig ab summerterm 2022

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:
Exercise: Completion of 5 - 8 assignments (equally weighted), 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:

(Recommended) Prerequisites:
none

Content:
The module provides insights into advanced topics in the recent development in sustainable real estate. Focal aspects are (amongst others): – green certificates, the challenges and implications; responsible investment in the real estate and the cost and benefits analysis; Environmental Social and Governance aspects in the real estate development; public funding for real estate and urban development; the partnership in the real estate development, project tax issues; digitalization and infrastructure, etc.
The module confronts the student with a variety of possibilities to apply their theoretical knowledge to practical issues in real estate development. Practitioners from the industry are invited to give lectures and have in-depth discussions with students.

Intended Learning Outcomes:
Upon successful completion of the module, the students are expected to have a deep understanding of key theoretical concepts in sustainability and real estate development, be able to appraise critically published work in the field, apply this knowledge to the analysis of practical real

estate problems, 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 consists of a series of lectures and in-depth discussions with industry leaders. Through in-depth discussions with practitioners from the real estate industry, students can create contact with the industry and know how to apply their knowledge in practice.

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

Reading List:
Lecture notes, publications

Responsible for Module:
Prof. Dr. rer. pol. Bing Zhu

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

Module Description

EI0699: Urban Energy Systems and modern infrastructure for cities | Stadtenergiesysteme und moderne städtische Infrastruktur [UESMIC]

Version of module description: Gültig ab summerterm 2019

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:
Die Modulprüfung besteht aus einer 60 minütigen Klausur, in der die Studierenden sowohl kurze Text- und Multiple-Choice-Fragen zur Prüfung der Methodenkompetenz, als auch einfache Rechenaufgaben zur Überprüfung der Beherrschung der vorgestellten Anwendungen und insbesondere den Berechnungen zur Auslegung von Komponenten der Infrastruktur bearbeiten. Weitere Textaufgaben dienen dazu die Fähigkeit die Größenordnung abzuschätzen auch wenn nur unvollkommene Informationen vorliegen zu prüfen. Die Klausur wird benotet und es sind keine Hilfsmittel zugelassen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
A short introduction to urban planning is given as an overarching framework. As the data base for further analysis, statistics about the population and employment as well as building data banks of example cities are used. The focus lies on an examination of the different energy demands such as room and process heating and cooling, electrical energy and fuels. These results are then applied to a multi-modal grid planning for remote heating and cooling and the electrical grid. In addition, a short introduction into water supply and food logistics as well as garbage and waste water disposal with a special emphasis on a possible energetic use of the latter is given. Furthermore, urban traffic is examined. An integrated and holistic view in all the named areas is always the guiding idea.

Intended Learning Outcomes:
After finishing this module the students understand the complexity of the technical system "city". They are able to repeat the build-up of building data banks as well as basics of geo information systems (GIS). Additionally, they can evaluate and perform order of magnitude estimates in this area. They understand the basics of the urban supply and disposal infrastructure, especially in the field of energy, as well as the urban climate and are able to analyze and, in simplified cases, calculate the relevant loss mechanisms. The students recognize the advantages of the multi-modal analysis as an important method for future urban planning.

Teaching and Learning Methods:
In the course of this module lectures and tutorials are given. The lectures are presentations which allow the covering of the width of topics discussed. For the tutorials the students get exercise sheets one week in advance to work on and the results are discussed at the blackboard in the tutorials. This helps to repeat and deepen the knowledge of the chosen topics.

Media:
There is a MOOC that was prepared based on the module lecture. In addition, several theses will be relevant. Details will be given at the beginning of the lectures.

Reading List:
Bott, Helmut; Grassl, Gregor C.; Anders, Stephan (Hg.) (2018): Nachhaltige Stadtplanung. Lebendige Quartiere - Smart cities - Resilienz. Institut für Internationale Architektur-Dokumentation. Zweite Auflage (überarbeitet und aktualisiert). München: Edition DETAIL (Edition DETAIL).
Keirstead, James; Jennings, Mark; Sivakumar, Aruna (2012): A review of urban energy system models: Approaches, challenges and opportunities. In: Renewable and Sustainable Energy Reviews 16 (6), S. 3847–3866. DOI: 10.1016/j.rser.2012.02.047.
World Urbanization Prospects - Population Division - United Nations. Online https://population.un.org/wup/Publications/
Bundesministerium für Ernährung und Landwirtschaft (BMEL) (Hg.) (2019): Deutschland, wie es isst. Der BMEL-Ernährungsreport 2019. Berlin.

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

Courses (Type of course, Weekly hours per semester), Instructor:
Stadtenergiesysteme und moderne städtische Infrastruktur (Vorlesung mit integrierten Übungen, 4 SWS)
Hamacher T, Odersky L, Molar Cruz A
For further information in this module, please click campus.tum.de or here.

Module Description

MW2245: Think. Make. Start. | Think. Make. Start. [TMS]

Build innovative products of your ideas in 10 days!

Version of module description: Gültig ab summerterm 2021

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

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 incl. written documentation (approx. 10 pages) and presentation (10 min), in which the students develop a new product in a group project and present their idea for founding a company on this basis. The individual performance is assessed to what extent the students are able to develop a product with market potential by means of an iterative approach to prototypical implementation. The assessment also includes the ability to work in a team, the ability to make well-founded design decisions and the completeness and conclusiveness of the concept, taking into account social relevance, novelty and innovation. As part of the project work, in addition to documentation, there is a final oral presentation. Through the presentation, students are expected to show whether they can demonstrate their ability to act as a competent team.

Repeat Examination:

(Recommended) Prerequisites:
The basic requirement is a willingness to engage with new learning methods, approaches, disciplines and ways of working. Cross-role experience in project management, product development (Design Thinking, TRIZ, Systems Engineering, etc), interdisciplinary teamwork, communication skills, creativity and problem solving skills are an advantage. A lot of emphasis is placed on practical experience.

For the "Problem Expert" role, experience in the following areas is an advantage:
- User Testing, Requirements Engineering, Interviewing, Human-Centered Design, Design, Visualisation, Use Case Definition, UX/UI Design, marketing, market research, benchmarking, design thinking.

For the "Tech Developer" role, experience in the following areas is an advantage:
- Hardware (mechanical): design, manufacturing (workshop/makerspace), prototyping, CAD/CAM.
- Hardware (electronic): embedded systems engineering, microcontrollers, sensors/actuators, Arduino, Raspberry, circuitry, board design, metrology, BUS protocols, prototyping, closed-loop/ open-loop control, robotics
- Software focus: Backend development, databases, frontend development, machine learning, web development, app development, embedded systems

For the "Business Developer" role, experience in the following areas is an advantage:
- Business Plan/Strategy/Design, Marketing, Sales, Interviewing, Finance & Accounting, Business Law & Regulations, Entrepreneurship.

The number of participants is limited and there will be an application process.

Content:
During the interdisciplinary team project, students work methodically, purposefully and agilely on a development project to develop innovative new products with the intention of successfully launching them on the market. Current needs and problems from social, technological and economic systems are identified, analysed and validated in the interdisciplinary team. In doing so, they cooperatively solve challenges that arise from constraints from the different disciplines. They generate suitable market hypotheses and product ideas at an early stage and interact with initial potential customers/users. They iteratively create prototypes and evaluate their hypotheses with them in experiments.

For more information, visit www.thinkmakestart.com and www.tms.tum.de.

Intended Learning Outcomes:
After the successful participation in the module, the students are able to:
- examine the relevance of a problem and develop a solution collaboratively in an interdisciplinary team.
- to discover the innovation potentials of new products / ideas, to evaluate the novelty and social relevance.
- To convert one's own ideas into a Minimum Viable Product and thus use potentials for one's own business start-up.
- To know methods of product development (from thinking to doing), to apply them independently and to evaluate the results (prototyping, design thinking, lean startup, agile, systems engineering).
- to reproduce the principles of user-centred design, to apply them independently and to evaluate them.
- Understand the context of use and analyse customer needs (where do I serve a need and what technology/method do I use).
- To quickly develop important hypotheses involving relevant stakeholders (customer, user, ...) through proper Planning with "purposeful prototyping".
- Change perspectives across disciplines and apply project management in interdisciplinary teamwork.

- To work independently, to make and justify decisions and to learn from one's own mistakes.
- To possibly lay the foundation for one's own business start-up by identifying a start-up idea or team.

Teaching and Learning Methods:
"THINK. MAKE. START." is a two-week, practice-oriented, interdisciplinary and competitive teaching format in which students from all faculties can participate (credits are given individually related to the study program). It is organised by the different chairs of TUM, TUM ForTe, and UnternehmerTUM. They get access to the high-tech workshop Makerspace and budget to transform their own ideas into real prototypes (mechatronic products). Learning outcomes are achieved through the following teaching and learning methods:
- Milestones to be achieved, team roles to be held and predetermined course structure provide the roadmap for the project.
- Coaching and teaching expertise in prototyping, business validation, agile development, design thinking, systems engineering, lean startup and user-centred design.
- Teaching the basics of interdisciplinary collaboration through a role concept (Business Developer, Tech Developer, Problem Expert).
- All participants work in interdisciplinary teams (10 teams of 5 students each) and are encouraged to become active themselves and learn through practical experience (hands-on learning).
- Each team pursues a real business idea chosen for the seminar. Special attention is given to really understanding the customer and verifying the solution approach, through questioning, observation, prototyping or expert discussion.
- Using prototyping to bridge the gap between thinking and doing.
- Reflecting on one's own results and approach supports project decisions.
- The teams present their projects to a jury on DemoDay and present the prototypically implemented product ideas to guests from industry, the start-up scene and research.

Media:
Project manual, presentations, hand-outs, posters, videos, examples.

Reading List:
Esch Franz-Rudolf (2012) Strategie und Technik der Markenführung, 7. Auflage, Vahlen

Faltin, Günter (2008): Kopf schlägt Kapital, Hanser

Halgrimsson (2012): Prototyping and Model Making for Product Design (2012)

Kalweit Andreas, Paul Christof, Peters Sascha, Wallbaum Reiner (2012) Handbuch für Technisches
Produktdesign, Material und Fertigung, Entscheidungsgrundlage für Designer und Ingenieure, 2. Auflage, Springer

Kelly, Tom (2016): The Art of Innovation

Lindemann, U (2007): Methodische Entwicklung technischer Produkte - Methoden flexibel und situationsgerecht anwenden. 2. Auflage

Münchener Business Plan Wettbewerb: Handbuch Businessplan-Erstellung, München http://www.evobis.de/coaching/handbuch/

Malek, Miroslaw / Ibach, Peter K. (2004): Entrepreneurship, Dpunkt Verlag

Moore, Geoffrey A. (2002): Crossing the Chasm, Harpercollins

Osterwalder, Alexander / Pigneur, Yves (2010): Business Model Generation: A Handbook for

Ries, Eric (2011): The Lean Startup

Savoia, Antonio (2019): The right It

Timmons, Jeffry A. / Spinelli, Stephen (2009): New Venture Creation, 7thedition, McGraw, Hill Professional

UnternehmerTUM (2011): Handbuch Schlüsselkompetenzen, 7. Auflage

Responsible for Module:
Zimmermann, Markus; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Think.Make.Start. (Praktikum, 4 SWS)
Zimmermann M [L], Martins Pacheco N, Bandle M, Förtsch T, Reif M, Baur C, Höller B, Thies A
For further information in this module, please click campus.tum.de or here.

Module Description

POL67000: Digital Sustainability Transformation of, by and for the TUM | Digital Sustainability Transformation of, by and for the TUM

Version of module description: Gültig ab summerterm 2022

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

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

Description of Examination Method:
The exam takes the form of a portfolio, consisting of two comments (20%), a project draft (20%) and an in-class project presentation (20%) as well as a public project presentation (20%) and a final report (20%), charting the progress of their work/research over time. Over the course of this module, students will have to complete the following tasks: Lecture: In order to demonstrate that they are able to understand and to critically discuss key aspects linked to sustainable and digital transformations, students have to actively contribute to two sessions of the lecture (one in the summer term, and one in the winter term) by writing a blog post, designing a digital story or short video, conducting an interview or producing a presentation to provide additional information on a selected topic. This counts 20% to the final grade. Seminar: Students have to develop a project and implement this over the course of the seminar. During the summer term, students need to prepare a project draft of min. 10 to max. 15 pages, in which they will show that they are able systematically plan and implement their own projects, and present their project in-class in order to demonstrate the progress of their work and to enhance their conversational and presentational skills. This counts 40% to the final grade (20% each for report and presentation). During the winter term, students need to present their project at the public conference to prove that they are able to present their work/research in an adequate manner to a scientific and broader audience and need to compile a final project report of min. 15 to max. 20 pages, in which they show that they are able to understand, identify and analyze how they can actively shape big transformations in their immediate vicinity. This counts 40% to the final grade (20% each for report and presentation).

Repeat Examination:

(Recommended) Prerequisites:
This module is aimed at all students enrolled in a 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.

Content:
Sustainability and digitization are two of the key challenges of our time. Both transformations must be actively shaped, whereby it is crucial to think "sustainability" and "digitization" not only as two separate megatrends but examine their intersections and interplays. Universities like the TUM have a central role to play in shaping the digital and sustainable transformation: they are learning venues for sustainable/digital development with the goal to educate people; they serve as fora for public discussions and as hubs to connect important stakeholders; they are important incubators for innovations; and they (should) also function as role models for the society. Against this backdrop, this module pursues three interrelated goals: 1) to promote the discussion of sustainable development issues in conjunction with the digital transformation at TUM; 2) to strengthen TUM's position as a driving force and central multiplier of issues with a view to sustainable digitization or sustainability through digitization; and 3) to support the deep-rooted anchoring of sustainability issues at TUM.

The module consists of two courses:
- The first course is a virtual lecture that examines the mutual opportunities and challenges of sustainability and digitization in the university context - i.e. in teaching, research, administration and third mission. In the summer term, the lecture will focus on a range of topics linked to sustainability and digitalization within the TUM. In other words, we will explore, among others, how sustainability matters for learning, working and living at the TUM, what initiatives are in progress to enhance issues related to sustainbility at the TUM. In doing so, we will also examine the question of sustainability & digitization within higher education and ask how sustainability and digitization can be thought together from theoretical perspective. In the winter term, the lecture will look at various issues and initiatives that address the mutual opportunities and challenges of sustainability and digitization at various levels. While a focus will be on projects in Munich and Bavaria, we will also discuss topics from a national, supranational and global perspective.
- The second course is a seminar which gives students the opportunity to apply their knowledge on topics related to sustainable digitization/digital sustainability in a project-based manner. Over the course of two semesters, students are asked to develop and implement their own projects. Concretely, the seminar envisages two tracks of potential projects: Track 1 is dedicated to sustainability governance at TUM where students will work in small groups on assessing individual components of a sustainability at the TUM and identify possible potential for action with regard to digitalization and sustainability. Track 2 focuses on developing concrete projects together with stakeholders and local actors, with the goal to work on solutions and applications.

The module closes with a conference where the student-led projects are presented to a broader audience and discussed with experts.

Intended Learning Outcomes:
After successful participation in this course, students are able:

- to understand and to critically discuss key aspects linked to sustainable and digital transformations, particularly in the context of higher education;
- to put their knowledge into practice for their own (research) project, and to systematically plan and implement their own projects;
- to analyze how they can actively shape big transformations in their immidiate vicinity,
- to demonstrate the progress of their work and to enhance their conversational and presentational skills,
- to present their work/research in an adequate manner to a scientific and broader audience.

Teaching and Learning Methods:
A range of teaching & learning techniques will be applied:
- The lecture combines (pre-recorded) videos and online presentations, with podcasts and interviews. To facilitate active participation with the content of the lectures, Q&A sessions, online discussions and additional participartory methods will be used.
- The seminar draws on the ideas of 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 assessed 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 ongoing and final results within the seminar and at a final conference.

Media:
The module is planned as a hybrid event combining online tools and in-person sessions (depending on the development of the Covid-19 pandemic). The lecture will be held online via Zoom or as pre-recorded videos; materials will be accessable via Moodle and YouTube. The seminars will be organized via Moodle and Zoom.

Reading List:
Sterling, St. et al. 2013. The Sustainable University. London: Routledge.
Filho, W. L. & P. Pace 2016. Teaching Education for Sustainable Development at University Level. Cham: Springer International.
Filho, W. L. et al. (eds.). 2019. Universities as Living Labs for Sustainable Development. Cham: Springer International.
Heinrichs, H. et al. (eds.). 2016. Sustainability Science. An Introduction. Cham: Springer International.

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

Courses (Type of course, Weekly hours per semester), Instructor:
(POL67000) Digital Sustainability Transformation of, by and for the TUM (Projekt) (Seminar, 2 SWS)
Siewert M (Mohammed N), Wurster S

(POL67000, POL67001) Digital Sustainability Transformation of, by and for the TUM
(Ringvorlesung) (Seminar, 2 SWS)
Wurster S (Mohammed N), Siewert M
For further information in this module, please click campus.tum.de or here.

Module Description

WI001278: What's cooking? Founding start-ups and unicorns in real time | What's cooking? Founding start-ups and unicorns in real time [What's cooking?]

What's cooking? Founding start-ups and unicorns in real time

Version of module description: Gültig ab winterterm 2020/21

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 12	**Total Hours:** 360	**Self-study Hours:** 270	**Contact Hours:** 90

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

Description of Examination Method:
The exams consist of several presentations based on a) summaries of current content of entrepreneurship and startup development as well as b) the creation of an own business venture (including the presentation of a prototype and a business plan). The project work should show that the students
- have researched and processed current academic and practice literature and other content (e.g., blogs, videos, podcasts, etc.) on startup creation and can visualize it properly
- have worked intensively on the topic of customer-centric business model development
- are able to develop business models using lean start-up methods of a project paper divided into a pitch presentation including the presentation of a prototype and a business plan. The project work should show that the students
- have presentation and communication skills that enable them to present their findings on challenging topics they are working on in a team in a clear and structured manner and to discuss the applicability of their findings in business practice.

The final grade is an average grade of an individual course work (50%; written aggregation of theories) and a team task (50%, pitch presentation, prototype and business plan)

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fluency in English

Interest in actually starting a venture this semester, current entreprenership, startup and venture capital content both from an academic and practice perspective

IMPORTANT: Available places will be allocated according to academic eligibility, relevant experience and skills. To register, please fill out the registration sheet (https://form.typeform.com/to/hLIs9pOQ) until September 30, 2021

Content:
The What's Cooking seminar is a highly interdisciplinary project-based learning experience that brings students from diverse backgrounds and TUM and LMU departments (e.g. management, computer science, engineering, architecture, etc.) together with respected startup and tech experts to develop startup ideas and found a startup in one semester.

Students from TUM and LMU will work in interdisciplinary teams and will analyze prevailing pain points of existing products and services and brainstorm ideas for high growth firms. Based on the identified pain points, students will start to build a startup that, in the best case scenario, will result in the creation of a company. Students will be supported by lectures from professors and invited entrepreneurs, serial founders, industry experts and investors as well as interactions with academics, in both methodological and entrepreneurial topics.
Student teams will consist of a balanced combination of students from all disciplines, e.g. computer science, physics, medicine, management, computer science, engineering as well as life science, etc.

All participants will go through workshops on identifying use cases, developing business ideas, prototyping, pitching, coaching by experts from academia and entrepreneurship practice and financial planning as well as peer-coaching. A large part of the seminar is based on actually working on startup building (in team work). Students are responsible for creating a prototype as well as a business model, developing a go-to-market strategy, and creating a VC-ready pitch deck.

At the end of the course, students will pitch their business idea to a selected group of high potential investors.

Intended Learning Outcomes:
Theory:
Students will research, read and summarize the most important academic concepts of startup building along the startup value chain. In addition students will also research, read and process thoughts and content from the most renowned and experienced actual entrepreneurs, VCs, movers and shakers in the entrepreneurial ecosystem.
They will learn to apply and aggregate fundamental concepts in all fields of digital technologies, emerging technologies across all industries, e.g. life sciences, Fintech, cybersecurity, FoodTech, Hr Tech, AI, Gaming, Blockchain, Robotics, EdTech, Deep Tech, E-Commerce, Energy, Construction, Agriculture, MedTech, IoT, Real Estate, Ventures for Good, and others.

Practice:

Students will gain dep knowledge of the most important players and actors that shape startup ecosystems worldwide as well as their ways of thinking and conceptualising. They will be able to summarize the key points of startup business ideas and disruption of established players. Students will apply customer centric prototyping by developing a disruptive idea based on pain points. Students will be able to perform technology assessment and prototype development

Method:
Students will learn from both academics and practitioners that shape, move and influence theory and practice of venturing and startup creation. We will work with academic journals, guest speakers as well as extracting knowledge from current videos, podcasts, conference presentations of the movers and thinkers of start-up business.

Teaching and Learning Methods:
The course consists of keynotes and a student-led project. The keynotes are given by university lecturers and guest lecturers who are leading experts in the fields of entrepreneurship and digitalization.

Media:
Power-Point, Videos, Zoom, Miro-Board, Moodle, Guest Speakers, Team Work, Coaching Sessions, Live Pitches, Peer Coaching

Reading List:
Books
Feld, B., & Mendelson, J. (2011). Venture deals. Wiley.
Sedniev, A. (2013) The Business Idea Factory: A World-Class System for Creating Successful Business Ideas. CreateSpace Independent Publishing Platform.
Bahcall, S. (2019). Loonshots: How to nurture the crazy ideas that win wars, cure diseases, and transform industries. St. Martin's Press.
Innovation, D. H. (2018). Digital innovation playbook: das unverzichtbare Arbeitsbuch für Gründer, Macher und Manager. Murmann Publishers.

Podcasts
Randoloph, M. (2021). Building Netflix, Battling Blockbuster, Negotiating with Amazon/Bezos, and Scraping the Barnacles Off the Hull. Retrieved from: https://podcastnotes.org/tim-ferris-show/marc-randolph-on-the-tim-ferriss-show/.
O'Shaughnessy P. (2021). Chamath Palihapitiya - The Major Problems Facing The World. Retrieved from: https://www.joincolossus.com/episodes/33654465/palihapitiya-the-major-problems-facing-the-world

Blogs
Altman, S. (2020). Idea Generation. Retrieved from: https://blog.samaltman.com/idea-generation

Videos

Thiel, P. & Perrel, D. (2021). Peter Thiel's Tips for Changing the World. Retrieved from: https://www.youtube.com/watch?v=f0DaNghFjdA&feature=youtu.be
Palihapitiya C. (2018). Chamath Palihapitiya and CEO Social Capital, on Money as an Instrument of Change . Retrieved from: https://www.youtube.com/watch?v=PMotykw0SIk

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

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

Skill Area - Building Services Engineering and Renewable Energies | Kompetenzfeld - Gebäudetechnik und Erneuerbare Energien

Module Description

AR30012: Occupational Health and Safety | Arbeitssicherheit

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German	**Duration:** two semesters	**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 Modulleistung wird in Form von einer schriftlichen Prüfung am Ende des Moduls erbracht. In dieser soll nachgewiesen werden, dass die Studierenden die wesentlichen Grundlagen im Arbeits- und Gesundheitsschutz verstehen und präzise wiedergeben können. Mit bestimmten Transferfragen wird nachgewiesen, ob die Studierenden problemlösungsorientiert handeln können. Alle Studierenden, die die Zusatzqualifizierung (gemäß Fachaufsichtsschreiben zur Fachkraft für Arbeitssicherheit des BMA vom 29. Dezember 1997) erwerben wollen gemäß §7 Arbeitssicherheitsgesetz, durchlaufen 4 Lernerfolgskontrollen (3 schriftliche, 1 mündliche). Die Ausbildungsmaßnahme (Wintersemester + Sommersemester) entspricht der von der Bundesanstalt für Arbeitsschutz und Arbeitsmedizin (BAuA) und der Deutschen Gesetzlichen Unfallversicherung (DGUV) erarbeiteten Ausbildungskonzeption und den darauf aufbauenden Ausbildungsmaterialien in Absprache mit der Berufsgenossenschaft der Bauwirtschaft (BG Bau), Fachabteilung Prävention Nord.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
keine

Content:
Im Modul Arbeitssicherheit werden wesentliche Modelle im Bereich Sicherheit und Gesundheit bei der Arbeit vorgestellt, diskutiert und auf Problemstellungen aus der Praxis angewendet.
Die Inhalte gliedern sich in die Themenblöcke Gefährdungs- und gesundheitsfördernde Faktoren, Gefährungsbeurteilung, Arbeitssystemgestaltung und Arbeitsschutzmanagement.

Intended Learning Outcomes:
Nach der erfolgreichen Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage,die grundlegenden Aspekte und Methoden des Arbeitsschutzes, insbesondere Gefährdungs- und gesundheitsfördernde Faktoren, Gefährdungsbeurteilung, Arbeitssystemgestaltung, Arbeitsschutzmanagement und Organisation zu verstehen und auf spezifische betriebliche Kontexte anzuwenden.
Die Studierenden lernen darüber hinaus, dass Recherchieren und adressatengerechtes Aufbereiten von rechtlichen Vorgaben des Arbeits- und Gesundheitsschutzes eine wichtige Rolle spielt und wie man mit diesen umgeht.

Teaching and Learning Methods:
Das Modul findet in Blöcken statt. Einführung in die Grundlagen, sowie Vertiefung der Thematik durch Vorlesungen. Präsentation vor der Gruppe und Hausarbeit zur Stärkung der Lernergebnisse. Die im Seminar vermittelten Kenntnisse werden im Eigenstudium an einer Aufgabenstellung vertieft behandelt.

Media:

Reading List:
Arbeitsschutzgesetz mit konkretisierenden Verordnungen und Technische Regeln:
Arbeitssicherheitsgesetz
Sozialgesetzbuch VII - Gesetzliche Unfallversicherung Unfallverhütungsvorschriften
Berufsgenossenschaftliche Regeln und Informationen

Responsible for Module:
Kirnberger, Simon

Courses (Type of course, Weekly hours per semester), Instructor:
Arbeitssicherheit II (Übung, 2 SWS)
Kirnberger S

Arbeitssicherheit (Übung, 2 SWS)
Kirnberger S, Zettelmeier C
For further information in this module, please click campus.tum.de or here.

Module Description

AR30044: Adaptive Building Concepts | Adaptive Gebäudekonzepte

Version of module description: Gültig ab summerterm 2018

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 performance has to be effected by presenting the acquired project work in groups and by handing in the written documentation of the project work. The student has to prove the understanding of the exposure of different climatic parameters and their adaption and application on the building.
The cumulative grade is comprised of your engagement relating to the project work. The presentation of the project work and the written documentation will be rated.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Participation of the lecture Climate Responsive Building I and II.

Content:
The building envelope as the interface of the interior and the exterior contains many features as natural lighting and ventilation. It is also one of the most important factors in energy performance of buildings regarding to heat loss and risk of overheating. The execution of the façade is the determining factor for the dimensioning of the room conditioning systems and the building technology. Additionally to that there is the variety of climatic conditions and urban situations.

Intended Learning Outcomes:
After passing the module the students will be able to evaluate climate data, allocate them to a location and to apply these as a design-determining parameter. They will also be able to estimate the possibility and limits of conditioning exclusively with passive measures.

Teaching and Learning Methods:
The mediated knowledge of lecture and seminar will be increased by working on a task in self-study. The results of the work will be examined as a presentation. During the presentations the students will share their knowledge with their fellow students.

Media:

Reading List:
Klimagerechtes Bauen - Ein Handbuch; Habitat - Vernacular Architecture for a Changing Planet. Sandra Piesik

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

Courses (Type of course, Weekly hours per semester), Instructor:
Adaptive Gebäudekonzepte (Übung, 2 SWS)
Vohlidka P, Zettelmeier C
For further information in this module, please click campus.tum.de or here.

Module Description

AR30036: Advanced Modeling | Advanced Modeling

energy and urban environmental analysis modules

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
General plan (subject to future modifications):
- Short Kick-off meeting [intro, background, installation]
1 session – 06.05.2021
- Energy modeling using EnergyPlus through Honeybee (Ladybug tools)
[Intro, definitions, settings, results]
2 sessions – 20.05.2021; 03.06.2021
- From building energy modeling to urban energy modeling [+Energy supply modeling]
1 session - 17.06.2021
- Intro to urban microclimatic modeling
1 session - 01.07.2021
- Advances workflows
[coupling tools, automated parametric workflows, advanced data visualization and analysis]
1 session – 15.07.2021

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Basic experience with Rhino; Basic knowledge about performance simulations.
Previous knowledge:
- Advanced Modeling course (Winter semester 2020-1, by Ata Chokhachian)
- Klimagerechtes Bauen I lecture series (by Prof. Thomas Auer)

Content:
This course will equip the participants with both the theoretical background as well as the practical hands-on experience to apply digital tools for environmental performance evaluations in early

design phases. Aligning directly with the previous advanced modeling module (Projektseminar 950495103), this module will complete the introduction of Ladybug tools by focusing on energy analysis conducted using Honeybee, as well as on other urban scale performance analysis workflows.

Intended Learning Outcomes:
The students will have a chance to experiment with Honeybee energy analysis components in their design process, learn how to set and run an energy simulation, explore and analyze the results, and ask the relevant questions and use them to find the preferred environmentally driven design solutions. Beyond energy performance evaluation, an important objective of this course is to expand the performative perspective from the single building to the urban scale. To achieve this aim, the students will be introduced with both the required background as well as effective tools to perform basic district scale environmental analysis. This course also aims to expose the students to advanced methods and workflow possibilities for their future individual exploration and development

Teaching and Learning Methods:
All sessions will be held virtually (via Zoom). Some sessions will start with background presentations (by Jonathan) which will be distributed to the students. The main part of each session will include a live demonstration of the tools which is expected be conducted simultaneously by the students using example files which will be pre-distributed to the students. Learning materials (lectures in PDF and sample files) will be distributed via Moodle before each session. Some session may be recorded for internal use or for redistribution to the students.

Media:
Powerpoint
Zoom
TUMonline

Reading List:
Grasshopper Primer, by Andrew Payne.
Ladybug Primer, by Mostapha Roudsari.
HoneyBee Primer, by Mostapha Roudsari
Honeybee installation instructions (you probably have Ladybug 0.0.69 and Honeybee 0.0.66 by now, but make sure you have openstudio) - https://github.com/ladybug-tools/lbt-grasshopper/wiki/1.1-Windows-Installation-Steps. URBANopt in not required for this course
Dragonfly installation instructions (Ver. 0.0.03) – https://github.com/ladybug-tools/dragonfly-legacy/wiki
OPTIONAL - Install Eddy3D https://www.eddy3d.com/support/documentation/ (CFD tool)
These Honeybee tutorials are very useful and cover most of what we will be looking at in the first two sessions –
https://www.youtube.com/watch?v=m8ncENwXpek&list=PLruLh1AdY-SgW4uDtNSMLeiUmA8YXEHT_
https://www.youtube.com/watch?v=ubkHdERn8a8&list=PLH8aDh9crYvOxzGjuCTKE4ti-STA8NfaH

That’s a detailed explanation of each component in Honeybee – https://mostapharoudsari.gitbooks.io/honeybee-primer/content/

These are useful Honeybee example files - https://hydrashare.github.io/hydra/?keywords=HBExampleFiles

Responsible for Module:
Chokhachian, Ata; M.Sc.

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

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

Module Description

AR72048: Green Technologies MA | Green Technologies MA [GTECH_MA]

Version of module description: Gültig ab summerterm 2018

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:
The module exam is a scientific documentation with a conceptual and a analytical part. This textual and graphic analysis of basics in the form of a study work shows the proof of learning of the module. This is accompanied by a presentation and discussion in order to test the communicative competence of presenting scientific topics to an audience.

Repeat Examination:
Next semester / End of Semester

(Recommended) Prerequisites:
The students should have an interest in topics of open space design and ecological issues (microclimate, water balance, etc.), having previously taken part in relevant courses.

Content:
At the center of Green Technologies module is the exploration of building techniques in which design of plants is functional, spatial, and creative.
Possible areas of focus are:

- Attitudes to "Green Architecture"
- Designing with growth processes
- vegetation technologies
- The greening of Buildings
- Green and blue-green infrastructure
- Baubotanik
- (city) climate and (city) ecology

Intended Learning Outcomes:
After attending this module, students are able to:
- define important terms in the field of green technologies.
- reflect the imparted fundamentals of green architecture and infrastructure.
- recognize, use and discuss the relationships between urban water management, vegetation use and urban climate.
- discuss the processes of "building" and "growing" in their diversity and translate them into hybrid concepts.
- select suitable vegetation approaches for construction tasks in the field of "green architectures".
- apply knowledge from the course of green technologies at different scales in order to independently analyze projects and to be able to develop their own concepts.
- present adequately the developed analyses and / or concepts through texts and graphics.

Teaching and Learning Methods:
The module is divided into two methodical parts:
- The teaching of fundamental knowledge and a general thematic overview through lectures, which may be also supplemented by guest speakers. On the basis of example projects, a deeper understanding of selected aspects of the topic is explored.
- Through self-led study in individual or group work, understanding of the course content will be extended and deepened in the form of guided content research, textual and graphic analysis, and through example concept developments. Regular presentations and discussions with the course group and teacher will help sharpen the project goals.

Media:
Slide Presentations, Drawings, CAD, Power-Point, Adobe Creative Suite

Reading List:

Responsible for Module:
Ferdinand Ludwig

Courses (Type of course, Weekly hours per semester), Instructor:
Green Technologies (Lebende Architektur) (Vorlesung, 2 SWS)
Ludwig F, Well F

Green Technologies (Lebende Architektur) (Seminar, 2 SWS)
Ludwig F, Well F
For further information in this module, please click campus.tum.de or here.

Module Description

BGU62052: Renewable Energy Supply in Buildings | Erneuerbare Energieversorgung von Gebäuden

Version of module description: Gültig ab summerterm 2021

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 is a written exam (90 minutes) in which students have to evaluate and apply various theories and findings relating to regenerative energy supply to buildings. The students have to answer some of the questions in their own words and make various calculations on their own.
The examination takes place online as an openbook exam via Moodle.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
no basic knowledge is needed

Content:
Students learn about the correlations between building design and room conditioning, as well as the systems this involves. The key levers of energy-efficient and sustainable design and building are conveyed and explained on the basis of project examples.
The lecture Supplying Buildings with Renewable Energy covers the following topics:
- Introduction: Links between energy efficiency – saving energy – renewable energy
- Renewable Energy Act (Erneuerbare-Energien-Gesetz), Renewable Energy Heat Act (Erneuerbare-Energien-Wärme-Gesetz)
- Principles and strategies of supplying heat and power based on renewable energy to buildings. Topics include: Potentials and typical combinations of several forms of renewable energy used to supply buildings; ecological and economic assessment of the systems involved
- Examples based on different building concepts (for example, energy-plus buildings)
- Local and district heating: Possible strategies for using renewable energy; limits of decentralized energy supply

Intended Learning Outcomes:
Students who have successfully completed the module are able to:
- describe and apply the correlations between building shell design, indoor climate and comfort requirements
- define the necessary room conditioning systems and methods
- apply the terms of the Renewable Energy Act (Erneuerbare-Energien-Gesetz) and the Renewable Energy Heat Act (Erneuerbare-Energien-Wärme-Gesetz)
- describe the links and correlations ranging from energy production to the supply of energy to buildings
- plan typical concepts for supplying renewable energy to buildings, including the foundations for ecological and economic assessments
- understand the foundations of designing district heating grids

Teaching and Learning Methods:
The lecture conveys knowledge about various renewable-energy technologies as well as the skills needed to assess them. While working on specific assignments in self-study, the students gain a deeper understanding of various applications. The lecture topics are relevant to the examination and complement each other in terms of content. The students acquire detailed knowledge about the application and specific characteristics of different energy supply components based on practical examples in order to develop optimal solutions within the integrated design process that takes account of the respective building concept.

Media:
Projector presentations, films, documents, exercises, tests

Reading List:
Sterner, Michael ; Stadler, Ingo: Energiespeicher - Bedarf, Technologien, Integration. 2. Aufl.. Berlin Heidelberg New York: Springer-Verlag, 2017.
Bernhard Lenz: Nachhaltige Gebäudetechnik : Grundlagen - Systeme - Konzepte. Berlin: Walter de Gruyter, 2012.
Pistohl, Wolfram ; Rechenauer, Christian ; Scheuerer, Birgit: Handbuch der Gebäudetechnik : Planungsgrundlagen und Beispiele. 1. Allgemeines, Sanitär, Elektro, Gas. 8. Aufl.. München, Unterschließheim: Werner, 2013.
Pistohl, Wolfram ; Scheuerer, Frankf ; Rechenauer, Christian: Handbuch der Gebäudetechnik : Planungsgrundlagen und Beispiele. 2. Heizung, Lüftung, Beleuchtung, Energiesparen. 8. Aufl.. München, Unterschließheim: Werner, 2013.

Responsible for Module:
Werner Lang sekretariat.enpb.bgu@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Erneuerbare Energieversorgung von Gebäuden (Vorlesung, 4 SWS)
Lang W [L], Kierdorf D, Kleeberger M, Lang W, Schwering K
For further information in this module, please click campus.tum.de or here.

Module Description

BGU66026: Shallow and Deep Geothermal Energy Use of Groundwater for environmental Engineers | Flache und Tiefe Geothermie von Grundwassersystemen für Umweltingenieure

Version of module description: Gültig ab winterterm 2016/17

Module Level: Master	**Language:** German	**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:
Mit der Klausur (60 min) wird geprüft, inwieweit die Studierenden in Wissensfragen die physikalischen Grundlagen der Geothermie, die physikalischen, geologisch/hydrogeologisch relevanten Parameter und die geothermischen Prozesse beschreiben können sowie in praxisnahen Fragestellungen die Untersuchungs- und Berechnungsmethoden für die Planung und Auslegung oberflächennaher Systeme fallspezifisch anwenden, sowie die Ergebnisse aus der Datenauswertung von Feld- und Bohrdaten, auch hinsichtlich Unsicherheiten und Risiken in der Geothermie, analysieren und bewerten können.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Empfohlen sind Grundkenntnisse der Geologie (Einführung in die Geologie für Umwelting.), Hydrogeologie (Grundwasserhydraulik) und der Thermodynamik.

Content:
Im Modul werden den Studierenden die Grundlagen der Geothermie sowie die Vorgehensweise und andere wichtige Aspekte bei Planung, Bau und Betrieb von geothermischen Anlagen vermittelt. Die Inhalte sind im Einzelnen:

• Physikalischen Grundlagen des Wärmestroms im Untergrund
• Relevante Parameter zur Beschreibung geothermischer Systeme
• Lagerstättentypen geothermischer Systeme
• Verfahren zur Planung, Exploration und Gewinnung bei tiefen geothermischen Systemen

• Nutzungsvarianten von oberflächennahen geothermischen Systemen und ihre Planung und Auslegung
• Rechtliche Grundlagen bei der Nutzung von oberflächennaher und tiefer Geothermie
• Ökonomische Betrachtung von oberflächennahen Systemen
• Unsicherheiten und Risikoabschätzung bei geothermischen Nutzungen

Intended Learning Outcomes:
Nach der erfolgreichen Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage:
• die Prozesse der Wärmeströmung im Untergrund hinsichtlich ihrer geothermischen Nutzung zu verstehen
• die Verfahren zur Erhebung und Auswertung von Daten (Felddaten, Bohrdaten) zu verstehen, welche die relevanten geothermischen Parameter abschätzen bzw. erheben.
• Verfahren zur Nutzung der oberflächennahen und tiefen Geothermie zu verstehen.
• Berechnungsmethoden zur Auslegung und Planung oberflächennaher Systeme anzuwenden, die Ergebnisse zu analysieren und zu bewerten.
• die Unsicherheiten und Risiken (z. B. Fündigkeits- und Bohrrisiken) in der Geothermie zu verstehen.

Teaching and Learning Methods:
Das zu Grunde liegende Konzept des Moduls ist das problembasierte Lernen. Der Kern des Moduls besteht aus Lehrgesprächen mit Präsentationen zur Nutzung der tiefen und oberflächennahen Geothermie. Anschließend werden die Lerninhalte durch Übungen umgesetzt und vertieft werden. Die Übungen beinhalten Aufgaben zur Planung und Auslegung geothermischer Systeme und zum Verständnis der relevanten geologisch-thermischen Prozesse in der Geothermie. Hierbei werden Aufgaben gestellt, welche die Studierenden in selbstständiger Arbeitsweise analysieren sollen. Die Ergebnisse der Studierenden werden in der Gruppe diskutiert und der Lösungsweg aufgezeigt. Die Ergebnisse der Übungen werden den Studierenden auf der e-learning Plattform zur Verfügung gestellt um den Lösungsweg in der Nachbearbeitung überprüfen zu können. Die Vorlesung und Übung wird nach Bedarf und Möglichkeit durch Gastdozenten aus der Praxis unterstützt.

Media:
Moodle e learning Plattform, wiki-Plattform, Power-Point Präsentationen, Übungsaufbaben am PC, Lehrgespräche, Diskussion, Gruppenarbeit

Reading List:
BANKS, D. (2012): An Introduction to Thermogeology. – Ground source heating and cooling. 2nd Edition, 526 S., Wiley-Blackwell, Sussex.
DIPIPPO, R. (2012): Geothermal Power Plants. – Principles, Applications, Case studies and Environmental Impact. – 600 S., Elsevier, Amsterdam.
GRANT, M. A. & BIXLEY, P. F. (2011): Geothermal Reservoir engineering. 2nd Edition, 359 S., Academic Press , Burlington.

HUENGES, E. (2010): Geothermal Energy Systems: Exploration, Development, and Utilization. - 463 S., Wiley VCH, Weinheim.
KALTSCHMIT, M., HUENGES, E. & WOLFF, H. [Hrsg.] (1999): Energie aus Erdwärme. – 265 S., Spektrum, Heidelberg.
KOENIGSDORFF, R. (2011): Oberflächennahe Geothermie für Gebäude. – 332 S., Frauenhofer IRB, Stuttgart.
OCHSNER, K. (2007): Geothermal Heat Pumps – A Guide for Planning and Installing. – 224 S., Cromwell Press, Trowbridge.
THOLEN, M. & WALTER-HERTKORN, S. (2008): Arbeitshilfen Geothermie. – 228 S., WVGW, Bonn.

Responsible for Module:
Kai Zosseder, kai.zosseder@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Einführung in die oberflächennahe und tiefe Geothermie (Vorlesung mit integrierten Übungen, 3 SWS)
Zoßeder K
For further information in this module, please click campus.tum.de or here.

Module Description

ED120001: Applied Fire Prevention | Angewandter Brandschutz

Version of module description: Gültig ab winterterm 2021/22

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

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

Description of Examination Method:
Die Modulprüfung wird in Form einer Projektarbeit erbracht, diese ist in Zwischenkritiken und einer Schlusskritik zu präsentieren. Bewertet wird die Projektarbeit als Gesamtes, die Projektarbeit besteht aus der umfänglichen Ausei-nandersetzung mit dem Thema Brandschutz in Verbindung mit einem selbst gewählten Entwurf des Architekturstudi-ums. Die Leistung wird über einzureichende Pläne, der Dokumentation des Projektverlaufs und der Schlusspräsenta-tion erbracht und beurteilt.

Repeat Examination:

(Recommended) Prerequisites:
Konzeptioneller Brandschutz AR17054

Content:
In der Veranstaltung werden die in der Vorlesung Konzeptioneller Brandschutz vermittelten Themengebiete vertiefend betrachtet.
Die Studierenden analysieren zusammen mit einem Betreuer, welcher Entwurf ihres bisherigen Studiums sich für die Vertiefung eignet und welcher Themenbereich bearbeitet werden soll, ob sich ein Gesamtkonzept des Gebäudes, ein Konzept eines Fassadendetails oder ein städtebaulicher Entwurf sich anbietet.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage:
- das erlangte Wissen im Hinblick auf die brandschutztechnische Ausbildung von Gebäuden eigenständig anzuwen-den und selbstständig zu erweitern
- individuelle Brandschutzkonzepte auf Basis von Verordnungen und Ingenieurmethoden zu entwickeln

- Brandschutzkonzepte auf den eigenen Entwurf zu übertragen

Teaching and Learning Methods:
Die Projektbearbeitung findet in großen Teilen im Selbststudium statt. Es wird als Gruppenarbeit oder Einzelarbeit organisiert.
Konzeptbesprechungen sowie Präsentationen im Lauf des Semesters fördern den kritischen Diskurs und die Reflexi-on der eigenen Arbeit.

Media:
TUMmoodle, Zoom, Powerpoint

Reading List:
Brandschutz Kompakt 2020/2021
Dipl.-Ing. Achim Linhardt Dipl.-Ing. Lutz Battran

Responsible for Module:
Jochen Mecus

Courses (Type of course, Weekly hours per semester), Instructor:
Angewandter Brandschutz (Seminar, 2 SWS)
Berghofer E [L], Mecus J, Zettelmeier C
For further information in this module, please click campus.tum.de or here.

Module Description

ED120002: Microclimate Research | Microclimate Research

Version of module description: Gültig ab winterterm 2021/22

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:
Die Prüfungsleistung des Moduls ist eine wissenschaftliche Ausarbeitung. Sie ist am Ende des Semesters in Form einer Hausarbeit mit 7-10 Seiten via TUMmoodle einzureichen.
Die Studierenden weisen in der Hausarbeit anhand der Bearbeitung eines Forschungsthemas des Lehrstuhls nach, dass sie die Methoden des wissenschaftlichen Arbeitens im Fachbereich Architektur anwenden können. Sie zeigen zudem, dass die architekturrelevante Fragestellung im Spannungsfeld von Wissenschaft und Kunst näher zu be-leuchten und dabei komplexere Zusammenhänge und Theorien in eigenen Worten wiedergeben und diskutieren kön-nen. Durch die Bewertung der Hausarbeit sowohl in ihrer Form als auch in ihrem Inhaltwird überprüft, ob die Studie-renden den grundsätzlichen Aufbau einer Forschungsarbeit verstanden haben als auch bearbeitete Themenkomple-xe nachvollziehbar wiedergeben können.

Repeat Examination:

(Recommended) Prerequisites:

Content:
Im Zentrum des Moduls "Microclimate Research" steht die Vermittlung theoretischer Grundlagen für selbständiges wissenschaftliches Arbeiten im Bereich von universitären Forschungsthemen.

In einem ersten Impulsvortrag werden die Grundlagen des Forschungsthemas behandelt. Fachexpert:innen vermit-teln die wesentlichen Grundlagen des Mikroklimas und dessen Auswirkung auf das Innen- und Außenraumklima sowie die Umgebung.

Der zweite Teil befasst sich insbesondere mit:
- dem grundsätzlichen Aufbau einer Forschungsarbeit,

- Grundlagen des wissenschaftlichen Informations- und Literaturmanagements, insbesondere der Nutzung von For-schungsdatenbanken und Literaturverwaltungsprogrammen,
- die Kenntnis und Nutzung von Datenquellen, insbesondere öffentliche Daten, und den Unterschied zwischen Daten, Information und Wissen,
- die Formulierung wissenschaftlicher Hypothesen und Forschungsfragen,
- das Erstellen eines Literaturverzeichnisses nach wissenschaftlichen Standards,
- die Wichtigkeit und Verfahrensweise der Vermeidung von Plagiaten.

Intended Learning Outcomes:
Nach Absolvieren des Moduls sind die Studierenden in der Lage

- die Herausforderungen zu verstehen, die auf Einwohner deutscher Städte aufgrund des Klimawandels zukommt
- Auswirkungen auf die Baubranche vorauszusagen, wenn unser Klima in 30 Jahren dem des heutigen Roms ent-spricht
- Veränderungen durch die Transformation des Gebäudebestandes zu analysieren und dabei ein Wohlfühlklima im Innen- und Außenraum zu berücksichtigen
- die Zusammenhänge Klimaschutz und Nachhaltigkeit bezüglich der Gebäudehülle zu bewerten
- selbstständig aktuelle Fragestellungen kritisch zu hinterfragen und angemessene Strategien und Lösungsansätze zu entwickeln.
- gelernte Themenkomplexe komprimiert widerzugeben sowie Präsentationen zu halten.
- den Zweck und die Ziele wissenschaftlichen Arbeitens im Fachbereich Architektur zu verstehen,
- das Fach Architektur als im Spannungsfeld von Wissenschaft und Kunst gelegen zu begreifen,
- den grundsätzlichen Aufbau einer Forschungsarbeit zu verstehen und anzuwenden,
- fachspezifische Informationsquellen zu erinnern, zur Recherche zu nutzen und wichtige Techniken und Werkzeuge des Informations- und Literaturmanagements anzuwenden,
- die Anforderungen an ein wissenschaftliches Literaturverzeichnis hinsichtlich Einheitlichkeit, Vollständigkeit und Nachvollziehbarkeit zu verstehen und anzuwenden.

Teaching and Learning Methods:
Das Modul besteht aus einer Kombination aus Vorträgen, Workshops, Präsentationen und Besprechungen.
Das nötige Grundlagenwissen wird durch Vorträge des Professors, einer Lehrstuhlmitarbeiterin sowie Expertinnen der Universitätsbibliothek vermittelt. Die Studierenden werden zum Studium der Literatur und zur inhaltlichen Ausei-nandersetzung mit den Themen angeregt.

Media:
Präsentationen, Videos, Literatur, TUMmoodle, Zoom

Reading List:
• Wissenschaftliches Arbeiten von Elisabeth Grenzebach
• TUM Bib – Literaturrecherche

Responsible for Module:
Laura Franke

Courses (Type of course, Weekly hours per semester), Instructor:
Microclimate Research - wissenschaftliches Arbeiten in der Forschung (supported by DesignFactory) (Seminar, 2 SWS)
Franke L [L], Franke L, Zettelmeier C
For further information in this module, please click campus.tum.de or here.

Module Description

EI70870: Modeling of Energy Systems | Modellierung von Energiesystemen

Version of module description: Gültig ab summerterm 2020

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

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

Description of Examination Method:
Examination with the following parts: Module examination by written exam (90 min). Theoretical knowledge is tested with short answer questions as well as multiple choice. In order to check the knowledge on algorithms and applications the students have to perform calculations in the exam. Essay-type questions are given to test for methodological knowledge on data quality and model applications, within others. The written exam will be graded.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor in natural sciences or engineering (fundamentals of higher mathematics and physics)

Content:
Introduction to mathematical modeling and its application to energy systems,
Mathematical optimization as an important tool for energy models,
Basics of economics as well as important concepts of energy economics,
General equilibrium theory and game theory with regard to energy and environmental problems,
System theory at the regional and global level,
Insight into the practice of modeling and the necessary data basis

Intended Learning Outcomes:
Upon successful completion of the course, students will be able to reflect on different approaches to modeling energy systems.
Students will be able to reproduce the necessary methods for optimization, economics modeling, game theory considerations and quantitative system models in an unchanged manner.

They can assess the problems of data collection and classify the quality of data. Based on this, the students can explain and build up optimization problems. They are able to classify and evaluate models used in practice in their function and statement. Likewise, they can assign given problems to a suitable modeling approach.

Teaching and Learning Methods:
Lectures, presentations and blackboard
Written exercise questions are to solved independently first and then discussed together.

Media:
The following media are used:
- Presentations
- Blackboard
- Exercise questions

Reading List:
Thie 2008, Introduction to Linear Programming and Game Theory, Wiley
Bhattacharyya 2011, Energy Economics, Springer
Erdmann 2010, Energieökonomik, Springer
Mankiw 2011 – Economics, South-Western
Bofinger – Grundzüge der Volkswirtschaftslehre, Pearson
Samuelson, Nordhaus 2005 – Economics, McGraw-Hill
Club of Rome – Die Grenzen des Wachstums, 1972
More literature recommendations can be found in the lecture notes.

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

Courses (Type of course, Weekly hours per semester), Instructor:
Modellierung von Energiesystemen (Vorlesung mit integrierten Übungen, 4 SWS)
Hamacher T, Gawlick J, Kerekes A, Reveron Baecker B
For further information in this module, please click campus.tum.de or here.

Module Description

EI7329: Energy Application Technology | Energieanwendungstechnik

Version of module description: Gültig ab summerterm 2017

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

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

Description of Examination Method:
Die Prüfungsleistung wird in Form einer benoteten schriftlichen Klausur mit 60 Minuten Dauer erbracht. Zu dieser Klausur sind keine Hilfsmittel zugelassen.
Die Studierenden beantworten Verständnisfragen zu Grundlagen der Energieanwendung und der eingesetzten Techologien.
Anhand von Rechenaufgaben wird überprüft, inwieweit die Studierenden in der Lage sind, Effizienz und Energieeinsatz der vorgestellten Technologien zu anaylsieren und zu bewerten.
Rechenschritte müssen nachvollziehbar dargestellt sein.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
keine Voraussetzungen

Content:
Grundsätzliche Wege zur rationellen Energieanwendung. Gewinnung und Verarbeitung energetischer Daten. Betriebsverhalten, energetische Bilanzen und Kennzahlen von Anlagen und Maschinen. Grundlagen und Techniken der Anwendung im Bereich von Raumwärme, Klimatisierung, Prozesswärme und -kälte, Kraft, Verkehr, Licht und IKT.

Intended Learning Outcomes:
Der Studierende ist nach erfolgreichem Abschluss des Moduls in der Lage:
- Grundlagen der Energieanwendung zu verstehen und einen Überblick zu geben.
- Die Anwendungsarten in den einzelnen Verbrauchssektoren zu verstehen und zu erläutern.
- Die vorgestellten Anwendungstechnologien hinsichtlich Effizienz, Kummuliertem Energieaufwand und Treibhausgasemissionen zu analysieren und zu bewerten.

Teaching and Learning Methods:
Vorträge, Präsentationen und Tafelarbeit
Diskussion aktueller Literaturquellen
Vorlesung mit begleitenden Übungen, dabei werden Gruppenarbeiten angestrebt, zu vorgegebenen Aufgaben sollen Lösungen erarbeitet werden.

Media:
Folgende Medienformen finden Verwendung:
- Präsentation
- Tafelarbeit
- Übungsaufgaben mit Lösungen

Reading List:
M. Rudolph; U. Wagner: Energieanwendungstechnik. Wege und Techniken zur effizienteren Energienutzung. Springer Verlag

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

Courses (Type of course, Weekly hours per semester), Instructor:
Energieanwendungstechnik (Vorlesung mit integrierten Übungen, 4 SWS)
Wagner U (Zinsmeister D, Zade M, Tzscheutschler P, You Z)
For further information in this module, please click campus.tum.de or here.

Module Description

EI7467: Interdisciplinary Project Internship Concept Development of a Renewable Energy System in a Developing Country | Interdisciplinary Project Internship Concept Development of a Renewable Energy System in a Developing Country [ProRESDC]

Interdisciplinary Student Project Concept Development of a Renewable Energy System in a Developing Country

Version of module description: Gültig ab winterterm 2016/17

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 135	**Contact Hours:** 45

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

Description of Examination Method:
The students' learning success will be determined by the following components of the project:

1. Input throughout the course of the milestone meetings (the supervisor of a team will rate each member of his team individually based on her or his input during the milestone meetings):
- Integration of the extraneous inputs, which his team members from other fields of study give, in order to develope a holistic concept for a renewable energy system in a developing country
- Analyzing the framework conditions, determining obstacles and deriving innovative solutions for renewable energy systems in developing countries before each milestone meeting
- Communication with the team leader and the other team members
- Meeting the timetable

2. Final presentation:
A jury will evaluate, how far the team manages to transfer their developed concept into an understandable context and to convince the audience of their choice of a certain concept. This includes the logic of the presentation, the focus on relevant points and appealing visualizations of their presentation slides.
In addition to this, each team member is individually evaluated for her or his presentation methods and expertise shown during the subsequent questions.

3. Project report (identic evaluation of all team members):

Here is rated how much convincing the decision was explained for the chosen energy concept and against other possible concepts due to the technological, financial and socio-cultural conditions and how comprehensible the implementation of the final concept was described.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
- Bachelor degree in a technical field of studies or in TUM-BWL
- Participation in "Series of lectures Renewable Energy Systems in Developing Countries"
- Interest in energy systems and their application / realization in developing countries
- Interest in the conversion of knowledge, which may differ from the field of her or his own studies on the one hand , but on the other hand is essential for the holistic understanding of their own study curriculum
- Interest in team-based project work and developing a realizeable concept
- Letter of motivation regarding study program, expertise, motivation and relevant experience (1.000 - 2.000 characters)

Content:
During the study project students develop a concept for the renewable energy system of a given location in a developing country.
During this concept development the variety of possible energy concepts will be reduced by general characteristics of stand-alone systems in the first step, followed by technological criteria in developing countries and socio-cultural impacts. Subsequently, the suitability of the various power production technologies, which are presented in the lectures, will be evaluated for the site in the developing country. Afterwards financing possibilities and framework conditions of regional market will be taken into account for the selection of the energy concept. In the end the final energy concept will be derived out of these sub steps.
Additionally the students derive options based on their developed energy concept, how to empower the population of the region economically by means of renewable energies.

Intended Learning Outcomes:
After participating in the project the students will be able to:
- understand extraneous knowledge concerning renewable energy systems in developing countries by the interdisciplinary collaboration with students from different study fields
- implement this interdisciplinary knowledge about energy systems in developing countries into action competences
- present the progress of a project target-oriented in meetings
- highlight the relevant technological, financial and sociocultural framework conditions of a planned energy system for a certain location in a developing country
- evaluate various options of energy supply concepts with based on their framework conditions
- manage the progress of a concept
- develop a suitable energy concept based on the requirements and possibilities of a defined location

- present convincingly their concept in a final presentation
- describe convincingly in a project report both the choice of their energy concept taking the involvement of all relevant aspects into account and the its realization

Teaching and Learning Methods:
Students are expected to achieve the learning outcomes by means of a project internship. Interdisciplinary teams of students, consisting of students from various faculties, develop a concept for a renewable energy system for a particular location in a developing country in defined milestones. Each team is advised by a scientific assistent, who is their team leader. This advisor is managing the technical expertise of the team members with her or his project experience during the weekly milestone meetings.
Finally, each team presents its energy concept in a final presentation and in a project report.
As a closing event there is offered a two-day excursion to an alpine mountain hut in Tyrol. Here both the the pros and cons of the concepts developed by the students are discussed to give the students the opportunity to reflect on their own work and that of their fellow students. Also the island energy system of the alpine hut, consisting of PV, biomass and battery storage, is shown in order to experience a realization of such a low-budget energy system.

Media:
- Practical presentation of components using PowerPoint slides and scripts for the subsequent experiments (practical events)
- PowerPoint slides to define the milestones
(milestone meetings)
- Final presentation using PowerPoint
- Project report using Word or Latex

Reading List:
- Engineers without Borders UK in 2014 - Engineering in Development
- Scripts for each practical event
- Other thematic literature on the recommendation of the speakers of the lecture series

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

Courses (Type of course, Weekly hours per semester), Instructor:
Interdisziplinäres Projektpraktikum Konzeptentwicklung eines Erneuerbaren Energiesystems in einem Entwicklungsland (Forschungspraktikum, 4 SWS)
Hamacher T, Bazan S, Cadavid Isaza A, Pant P
For further information in this module, please click campus.tum.de or here.

Module Description

EI74831: Project Lab Renewable and Sustainable Energy Systems | Project Lab Renewable and Sustainable Energy Systems [PropENS]

Version of module description: Gültig ab winterterm 2018/19

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

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

Description of Examination Method:
Participants of the Project Lab Renewable and Sustainable Energy Systems should carry out analyses, planning and applications about renewable energy systems and their modelling.
A team of 3-5 students should achieve a goal defined for the group over the duration of the lecture period of the semester within the framework of the project work. The problem definition, role distribution, idea development as well as the choice of suitable instruments, implementation and documentation are to be developed essentially independently by the group. The essential aspects of the work within the framework of the project internship (e.g. essential scientific contents, the treatment of a task as a completed project, division of the task among the group members) should be documented in a written report (volume: 15-20 pages).
In a supplementary presentation, the competence of the students to present their work in a structured way in a small seminar in front of an audience consisting of staff members of the chair and students will be examined. Overall, competencies in project work in the team as well as in documentation and presentation of the work should be demonstrated. The report is included in the grade with 40 %, the presentation and the cooperation in the team with 30%.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge about:
- Power systems
- Renewable energies (potentials, technologies)
- Matlab / Simulink

Content:
These are research-related and practice-oriented tasks whose topics are in line with the current research areas of the chair, such as:
- Modeling, simulation and / or regulation of energy systems
- Investigation of the potential of renewable energies
- Analysis and generation of data for energy systems
- Evaluation and interpretation of model results
- Planning and installation of plants for the use of renewable energies on the Campus Garching

Intended Learning Outcomes:
After successfully completing the module, the student is - depending on the topic - able to:
- recognize challenges of integrating renewable energies,
- apply and implement appropriate tools and methods to analyze, plan or regulate energy systems,
- interpret and evaluate results from applied models.

Teaching and Learning Methods:
Project tasks are carried out individually or preferably in groups of 2-4 students. In the process, self-dependence respectively teamwork is supported in the processing of a project task. Depending on the topic, a literature research may be necessary. The main part of the project internship, however, is the computer-aided development of analysis and evaluation tools or the planning and execution of laboratory tests or installations.
The participants will finally have the opportunity to practice preparing and holding presentations.

Media:
- Application of various programs or programming languages (Matlab / Simulink, Python, etc.)
- Test benches (renewable energy conversion plants, real-time simulator, measuring instruments)
- Presentations

Reading List:
Konstantin, Panos: Praxisbuch Energiewirtschaft - Energieumwandlung, -transport und -beschaffung, Übertragungsnetzausbau und Kernenergieausstieg, Springer Vieweg, Springer-Verlag GmbH Deutschland, eBook ISBN 978-3-662-49823-1, DOI 10.1007/978-3-662-49823-1, Hardcover ISBN 978-3-662-49822-4

Wagner, Ulrich; Heilek, Christian (Bearb.): Nutzung regenerativer Energien (Vorlesungsskript), 10., vollständig überarbeitete Auflage, Herrsching, E & M, Energie-&-Management-Verl.-Ges., 2009, ISBN: 978-3-9805179-3-5

The Power of Transformation - Wind, Sun and the Economics of Flexible Power Systems, International Energy Agency, OECD/IEA, 2014, France, ISBN: 978 92 64 20803 2

Hillier, Frederick S., Lieberman, Gerald J.: Introduction to operations research, New York, McGraw-Hill Education, 2015, ISBN: 978-0-07-352345-3, 0-07-352345-3, 978-0-07-126767-0, 978-1-259-25318-8, 1-259-25318-X

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

Courses (Type of course, Weekly hours per semester), Instructor:
Projektpraktikum Erneuerbare und Nachhaltige Energiesysteme (Forschungspraktikum, 4 SWS)
Hamacher T, Kuhn P, Breuning L, Cadavid Isaza A, de la Rua Lope C, Halilovic S, Kerekes A, Kleeberger H
For further information in this module, please click campus.tum.de or here.

Module Description

MW0174: Building Aerodynamics | Aerodynamik der Bauwerke

Version of module description: Gültig ab winterterm 2016/17

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

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

Description of Examination Method:
The module exam is based on a written exam of 90 minutes. The examination should proof the achieving of all educational objectives. Students have to answer both knowledge and comprehension questions as well as creating and interpreting graphs. Hereby they shall demonstrate the comprehension of basics and coherences of building aerodynamics. Also they shall identify possible threats in the sense of aerodynamics. Besides of writing and drawing tools a non-programmable calculator is allowed.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fundamentals in fluid mechanics
Recommended but not mandatory:
Turbulent flows,
Experimental fluid mechanics

Content:
Lecture:
- Basic aerodynamics: The physical properties of a fluid, state of motion (kinematics), conservation of mass (continuity), conservation of energy (Bernoulli’s equation), boundary layer flow, flow separation.
- Wind tunnel modelling and experimental techniques, similarity laws, aerodynamic coefficents.
- Characteristics of the atmospheric boundary layer: Wind velocity profil near the ground, turbulence structure of the wind, extreme wind data, influence of topography, design wind speed used in Code of Practise.

- Steady wind loads on structures: Wind pressure, forces and moments. Wind loads on parts of buildings, aerodynamic coefficients used in Code of Practise. Wind effect on heating and ventilation systems.
- Dynamic wind effects on structures and building oscillations: Vortex excited vibrations, gust excited vibrations, oscillations caused by aerodynamic instability, dynamic interference.
- Wind climate in cities: Wind effects on pedestrians, wind shelter by man-made and natural wind breaks.
- Dispersion of pollutants near buildings.

Intended Learning Outcomes:
Students who pass the final exam will have good knowledge on
- fundamentals of aerodyanmics of buildings
- the flow around buildings and stuructures and on aerodynamic forces as well as on methods to propagate the flow induced vibrations and on how to prevent them
- dynamic response of high rise buildings on gust exitation
- wind speeds in the vicinity of buildings
- contaminant dispersion in the environment of buildings

Proficiency in:
- Assessment skills on wind pressure on buildings
- Methods to optimize the flow around structures with respect ot reduce wind loads
- Methods to reduce and attenuate structure oscillations
- Wind tunnel simulation technique

Competences:
- Recognition, understanding and application of engineering methods in building aerodynamics
- Pursuance of aerodynamic development strategies in building design
- Successful transfer of aerodynamic development targets in building design

Teaching and Learning Methods:
In the lecture the teaching material is presented by the use of laptop and beamer. Additionally, important coherences and examples are discussed on the blackboard. The presentation slides will be offered online for the students.

Media:
PP Presentations,
web access to lecturing material

Reading List:
E. Simiu, R. H. Scanaln: "Wind effects on structures"
H. Sockel: "Aerodynamik der Bauwerke"
H. Ruscheweyh: "Dynamische Windwirkung auf Bauwerke"

Responsible for Module:
Pernpeintner, Albert; Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Aerodynamik der Bauwerke (MW0174) (Vorlesung, 2 SWS)
Breitsamter C (Cerny M)
For further information in this module, please click campus.tum.de or here.

Module Description

MW1475: Renewable Energy Technology 1 | Regenerative Energiesysteme 1 [RET I]

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:** 60	**Contact Hours:** 30

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

Description of Examination Method:
The exam takes 60 minutes and consists of a number of short questions on certain aspects of the topics presented as well as some calculations. Allowed auxiliary are writing and drawing utensils and a non programmable calculator.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic thermodynamics and fluid dynamics

Content:
Content:
This course offers an insight into renewable energy sources, and the existing technologies to use them. It also looks to present the political framework of renewable energy technology, as well as societal and ecological aspects from a global point of view. The course is recommended for students not majoring in the field, who are interested in gaining an overview of renewable energy systems.
The course RENEWABLE ENERGY TECHNOLOGY (taught in English) is split into two modules 3 ECTS each (one per semester), beginning with “RET I” in the Winter Semester. The attached module “RET II” will be offered in the Summer Semester.
The course is supported by various institutions of the TUM: The Institute for Energy Systems, the Institute for Renewable and Sustainable Energies, The Institute for Wind Energy, The chair of Hydraulic and Water Resources Engineering as well as the “Laboratory of Steam Boilers and Thermal Plants” from the National Technical University of Athens.

The module “RET I” covers the following topics:

• Fundamentals
• Energy from Biomass
• Geothermal Energy
• Wind Energy

In the module “RET II” the following topics are covered:
• Hydropower
• Solar Thermal Energy
• Photovoltaics

From the winter semester 2017/2018 onwards
the module "RET I" covers the following topics:
• Fundamentals
• Energy from Biomass
• Geothermal Energy
• Hydropower

whereas the module "RET II " is composed as follows:
• Wind Energy
• Solar Thermal Energy
• Photovoltaics

Intended Learning Outcomes:
After the participation in the module the students are able to understand the basics of the most relevant renewable energy technologies.
The gained knowledge enables the students to describe the fields of application as well as the limits of the presented renewable forms of energy. Moreover, the students are able to explain the elementary aspects of renewable energies from a physical, technical, and economical point of view.
They are familiar with technological solutions of all the presented renewable forms of energy and are able to classify their fields of application.
In addition, the students are able to identify the most suitable technology for a given field of application with particular focus on key physical, technical, and economical issues. In this context, the students are able to list and explain the environmental, economic, and social impacts of the selected technology.

Teaching and Learning Methods:
90 min lecture including discussion on the current topic per week. Students are encouraged to take part in the discussion and to question the arguments given by the lecturer. Autonomous preparing at home is needed to fully understand the learning matter.

Media:
Powerpoint presentations

Reading List:
German Literature:
Kaltschmitt, Martin: Erneuerbare Energien. Springer Verlag, Berlin

Quaschning, Volker: Regenerative Energiesysteme. Technologie - Berechnung - Simulation. Carl Hanser Verlag, München

Heliß, Michael: Regenerative Energiequellen. Praktikum. Springer Verlag, Berlin

Mohr, Markus: chancen erneuerbarer Energiequellen. Springer Verlag, Berlin

English Literature:
Spliethoff, Hartmut: Power Generation from Solid Fuels. Springer Verlag, Berlin

Boyle: Renewable Energy. Oxford University Press

Kaltschmitt, Martin: Renewable Energy: Technological Foundations, Economical and Environmental Aspects. Springer Verlag, Berlin

Wengenmayr, Roland: Renewable Energy: Soustainable Energy Concepts for the Future. Wiley-VCH Verlag

International energy Agency: Energy Technology Perspectives - Scenarios & Strategies to 2050

International Energy Agency: World Energy Outlook

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

Courses (Type of course, Weekly hours per semester), Instructor:
Regenerative Energiesysteme I (Vorlesung, 2 SWS)
Roeder G [L], Spliethoff H, Kunze C, Roeder G, Wieland C
For further information in this module, please click campus.tum.de or here.

Module Description

MW1476: Renewable Energy Technology 2 | Regenerative Energiesysteme 2 [RET II]

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
The exam takes 60 minutes and consists of a number of short questions on certain aspects of the topics presented as well as some calculations. Allowed auxiliary are writing and drawing utensils and a non programmable calculator.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic thermodynamics and fluid dynamics.

Content:
Content:
This course offers an insight into renewable energy sources, and the existing technologies to use them. It also looks to present the political framework of renewable energy technology, as well as societal and ecological aspects from a global point of view. The course is recommended for students not majoring in the field, who are interested in gaining an overview of renewable energy systems.
The course RENEWABLE ENERGY TECHNOLOGY (taught in English) is split into two modules 3 ECTS each (one per semester), beginning with “RET I” in the Winter Semester. The attached module “RET II” will be offered in the Summer Semester.
The course is supported by various institutions of the TUM: The Institute for Energy Systems, the Institute for Renewable and Sustainable Energies, The Institute for Wind Energy, The chair of Hydraulic and Water Resources Engineering as well as the “Laboratory of Steam Boilers and Thermal Plants” from the National Technical University of Athens.

The module “RET I” covers the following topics:

• Fundamentals
• Energy from Biomass
• Geothermal Energy
• Wind Energy

In the module “RET II” the following topics are covered:
• Hydropower
• Solar Thermal Energy
• Photovoltaics

From the winter semester 2017/2018 onwards
the module "RET I" covers the following topics:
• Fundamentals
• Energy from Biomass
• Geothermal Energy
• Hydropower

whereas the module "RET II " is composed as follows:
• Wind Energy
• Solar Thermal Energy
• Photovoltaics

Intended Learning Outcomes:
After the participation in the module the students are able to understand the basics of the most relevant renewable energy technologies.
The gained knowledge enables the students to describe the fields of application as well as the limits of the presented renewable forms of energy. Moreover, the students are able to explain the elementary aspects of renewable energies from a physical, technical, and economical point of view.
They are familiar with technological solutions of all the presented renewable forms of energy and are able to classify their fields of application.
In addition, the students are able to identify the most suitable technology for a given field of application with particular focus on key physical, technical, and economical issues. In this context, the students are able to list and explain the environmental, economic, and social impacts of the selected technology.

Teaching and Learning Methods:
90 min lecture including discussion on the current topic per week. Students are encouraged to take part in the discussion and to question the arguments given by the lecturer. Autonomous preparing at home is needed to fully understand the learning matter.

Media:
Powerpoint presentations

Reading List:
German Literature:
Kaltschmitt, Martin: Erneuerbare Energien. Springer Verlag, Berlin

Quaschning, Volker: Regenerative Energiesysteme. Technologie - Berechnung - Simulation. Carl Hanser Verlag, München

Heliß, Michael: Regenerative Energiequellen. Praktikum. Springer Verlag, Berlin

Mohr, Markus: chancen erneuerbarer Energiequellen. Springer Verlag, Berlin

English Literature:
Spliethoff, Hartmut: Power Generation from Solid Fuels. Springer Verlag, Berlin

Boyle: Renewable Energy. Oxford University Press

Kaltschmitt, Martin: Renewable Energy: Technological Foundations, Economical and Environmental Aspects. Springer Verlag, Berlin

Wengenmayr, Roland: Renewable Energy: Soustainable Energy Concepts for the Future. Wiley-VCH Verlag

International energy Agency: Energy Technology Perspectives - Scenarios & Strategies to 2050

International Energy Agency: World Energy Outlook

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

Courses (Type of course, Weekly hours per semester), Instructor:
Regenerative Energiesysteme II (Vorlesung, 2 SWS)
Roeder G [L], Hamacher T, Bottasso C, Breuning L, Roeder G, Sucameli C, Vannahme A, Wieland C
For further information in this module, please click campus.tum.de or here.

Module Description

MW2238: Energy from Biomass and Residuals | Energetische Nutzung von Biomasse und Reststoffen

Version of module description: Gültig ab winterterm 2015/16

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

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

Description of Examination Method:
Die Modulprüfung erfolgt in Form einer Übungsleistung, die sich aus einer mündlichen Prüfung (Dauer 30 min, Einzelprüfung, keine Hilfsmittel) ergibt.
In der mündlichen Prüfung sollen die Studierenden nachweisen, dass sie die Rahmenbedingungen und Mechanismen der unterschiedlichen Arten zur energetischen Nutzung von Biomasse und Reststoffen verstehen und auf unterschiedliche Problemstellungen anwenden können. Dazu zählen z. B. biologische Umsetzungsverfahren wie Fermentation, thermochemische Umwandlungsverfahren wie Verbrennung oder Vergasung oder physikalische Umwandlungsverfahren wie Zerkleinern oder Trocknen sowie anschließende Prozesse zur Erzeugung von Strom, Wärme und Treibstoffe. Dazu soll ein Verständnis für unterschiedliche Arten von Biomasse und Reststoffen sowie ihr bevorzugtes Einsatzfeld entwickelt werden.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
keine

Content:
Die Vorlesung behandelt die Möglichkeiten und Rahmenbedingungen für die energetische Nutzung von Biomasse und Reststoffen.

Im ersten Teil der Vorlesung werden Konzepte zur Nutzung biogener Stoffe und zur Entsorgung von Reststoffen vorgestellt. Neben konventionellen Nutzungskonzepten für die Wärme- und Stromerzeugung werden auch innovative Konzepte wie Vergärung, Pyrolyse und Vergasung, die Herstellung von Treibstoffen und die Anwendung neuer Technologien wie Brennstoffzelle, ORC-Prozess und Stirlingmotor behandelt.

Der zweite Teil der Vorlesung behandelt die verfahrenstechnischen Grundlagen dieser Konzepte. Dabei stehen vor allem technologische Probleme bei Verbrennung und Vergasung verschiedenster Brennstoffe und die Brennstofflogistik im Vordergrund.

Ergänzend zur Vorlesung kann das Seminar "Energetische Nutzung von Biomasse und Reststoffen" belegt werden. Hierbei steht die Planung dezentraler Versorgungs- und Entsorgungsanlagen im Mittelpunkt.

Intended Learning Outcomes:
Nach Teilnahme am Modul „Energetische Nutzung von Biomasse und Reststoffen mit Seminar“ verstehen Studierende die Rahmenbedingungen und Mechanismen bei der biologischen, physikalischen und thermo-chemischen Umwandlung von Biomasse. Sie sind in der Lage, konventionelle und innovative Konzepte (z. B. Vergärung, Pyrolyse und Vergasung) unter Berücksichtigung wirtschaftlicher und genehmigungsrechtlicher Rahmenbedingungen hinsichtlich der Einsetzbarkeit zur Bereitstellung von Wärme und Strom zu analysieren.
Sie können vorhandene und neue Konzepte hinsichtlich technischer, wirtschaftlicher und ökologischer Machbarkeit bewerten, sowie eigene, auch neuartige Konzepte zur Bereitstellung und energetischen Nutzung von Biomasse entwerfen und die Absatzwege und -strategien der erzeugten Endenergie planen.

Teaching and Learning Methods:
In der Vorlesung werden die theoretischen Grundlagen durch Vortrag, Präsentation, Tafelanschrieb, Verwendung von Multimedia-Komponenten (Filme und Animationen) sowie Funktionsmodelle vermittelt. Den Studierenden werden die Inhalte der Vorlesung durch ein gedrucktes Skript, sowie durch Multimediakomponenten im eLearning-Portal zugänglich gemacht. Zudem erfolgt im Rahmen der Vorlesung eine Exkursion zu einer Biomasse-Konversionsanlage (z.B. Heizkraftwerk, Kläranlage, Vergasungskraftwerk, …). Hier können die Studenten erlernte Sachverhalte an real existierenden Anlagen wiederfinden und zur Anwendung bringen.

Media:
Vortrag, Präsentation, Handzettel, Tafelanschrieb, Online-Lehrmaterialien (Multimedia)

Reading List:
Karl, J.: Dezentrale Energiesysteme. 2. Aufl., München: Oldenbourg Wissenschaftsverlag, 2006
Fachagentur Nachwachsende Rohstoffe (Hrsg.): Leitfaden Bioenergie - Planung, Betrieb und Wirtschaftlichkeit von Bioenergieanlagen. Gülzow, 2006
Kaltschmitt, M: - Energie aus Biomasse (2009)

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

Courses (Type of course, Weekly hours per semester), Instructor:
Energetische Nutzung von Biomasse und Reststoffen (Vorlesung, 2 SWS)
Fendt S [L], Spliethoff H, Ewald A, Fendt S, Johne P

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

Module Description

MW2244: Energy from Biomass and Residuals with Seminar | Energetische Nutzung von Biomasse und Reststoffen mit Seminar

Version of module description: Gültig ab summerterm 2019

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

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

Description of Examination Method:
Die Modulprüfung erfolgt in Form einer Übungsleistung, die sich aus einer mündlichen Prüfung (Dauer 30 min, Einzelprüfung, keine Hilfsmittel) und einer Gruppenarbeit (Seminar) zusammensetzt. Die Gruppenarbeit wird anhand der Abgabe eines Abschlussberichtes sowie einer zehn minütigen Abschlusspräsentation bewertet. Die Bewertung der Seminarnote erfolgt zu 60% zu Gunsten des Berichtes und zu 40% zu Gunsten der Präsentation. Die Gesamtnote für das Modul ergibt sich aus der Bewertung der Seminararbeit zu 40% und der mündl. Prüfung zu 60% (gewichtet entsprechend nach ECTS).
In der mündlichen Prüfung sollen die Studierenden nachweisen, dass sie die Rahmenbedingungen und Mechanismen der unterschiedlichen Arten zur energetischen Nutzung von Biomasse und Reststoffen verstehen und auf unterschiedliche Problemstellungen anwenden können. Dazu zählen z. B. biologische Umsetzungsverfahren wie Fermentation, thermochemische Umwandlungsverfahren wie Verbrennung oder Vergasung oder physikalische Umwandlungsverfahren wie Zerkleinern oder Trocknen sowie anschließende Prozesse zur Erzeugung von Strom, Wärme und Treibstoffe. Dazu soll ein Verständnis für unterschiedliche Arten von Biomasse und Reststoffen sowie ihr bevorzugtes Einsatzfeld entwickelt werden.
In der Gruppenarbeit entwickeln die Studierenden selbstständig ein spezifisches energetisches Nutzungskonzept für Biomasse und bewerten dieses anschließend techno-ökonomisch sowie ökologisch. Das Nutzungskonzept soll einen realen Standort mit der Nutzung lokal verfügbarer Biomasse und sinnvoller Endenergieeinbringung abbilden. Dadurch zeigen die Studierenden, dass sie in der Lage sind in der Vorlesung erlangtes Wissen auf ein reales Beispiel unter den entsprechenden wirtschaftlichen, rechtlichen und technischen Rahmenbedingungen anzuwenden. Das erarbeitete Konzept wird im Rahmen eines Abschlussberichtes zusammengefasst und anschließend in einer Abschlusspräsentation vor einer Jury aus Wirtschafts- und Wissenschaftsvertretern vorgestellt. Zum Abschluss wird das am besten bewertete Konzept gekürt. Lernziel ist es fachlich ausgearbeitete Zusammenhänge mündlich zu präsentieren und überzeugend Außenstehenden vorzutragen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
keine

Content:
Die Vorlesung behandelt die Möglichkeiten und Rahmenbedingungen für die energetische Nutzung von Biomasse und Reststoffen.
Im ersten Teil der Vorlesung werden Konzepte zur Nutzung biogener Stoffe und zur Entsorgung von Reststoffen vorgestellt. Neben konventionellen Nutzungskonzepten für die Wärme- und Stromerzeugung werden auch innovative Konzepte wie Vergärung, Pyrolyse und Vergasung, die Herstellung von Treibstoffen und die Anwendung neuer Technologien wie Brennstoffzelle, ORC-Prozess und Stirlingmotor behandelt.
Der zweite Teil der Vorlesung behandelt die verfahrenstechnischen Grundlagen dieser Konzepte. Dabei stehen vor allem technologische Probleme bei Verbrennung und Vergasung verschiedenster Brennstoffe und die Brennstofflogistik im Vordergrund.
Im begleitenden Seminar "Energetische Nutzung von Biomasse und Reststoffen" steht die Planung dezentraler Versorgungs- und Entsorgungsanlagen im Mittelpunkt. Dabei sollen von den Teilnehmern individuell gewählte Beispiele ausgearbeitet und anhand einer Wirtschaftlichkeitsrechnung und der genehmigungsrechtlichen Rahmenbedingungen beurteilt werden.

Intended Learning Outcomes:
Nach Teilnahme am Modul „Energetische Nutzung von Biomasse und Reststoffen mit Seminar“ verstehen Studierende die Rahmenbedingungen und Mechanismen bei der biologischen, physikalischen und thermo-chemischen Umwandlung von Biomasse. Sie sind in der Lage, konventionelle und innovative Konzepte (z. B. Vergärung, Pyrolyse und Vergasung) unter Berücksichtigung wirtschaftlicher und genehmigungsrechtlicher Rahmenbedingungen hinsichtlich der Einsetzbarkeit zur Bereitstellung von Wärme und Strom zu analysieren.
Sie können vorhandene und neue Konzepte hinsichtlich technischer, wirtschaftlicher und ökologischer Machbarkeit bewerten, sowie eigene, auch neuartige Konzepte zur Bereitstellung und energetischen Nutzung von Biomasse entwerfen und die Absatzwege und -strategien der erzeugten Endenergie planen.

Teaching and Learning Methods:
In der Vorlesung werden die theoretischen Grundlagen durch Vortrag, Präsentation, Tafelanschrieb, Verwendung von Multimedia-Komponenten (Filme und Animationen) sowie Funktionsmodelle vermittelt. Den Studierenden werden die Inhalte der Vorlesung durch ein gedrucktes Skript, sowie durch Multimediakomponenten im eLearning-Portal zugänglich gemacht.
Im Rahmen des Seminars werden die Grundlagen durch Vortrag und Tafelanschrieb vermittelt. Die Studierenden erhalten ebenso ein Skript mit den Inhalten des Vortrags sowie Arbeitsunterlagen mit Formelsammlung, Datentabellen etc. Im Rahmen des Seminars erarbeiten die Studierenden selbständig Konzepte zur energetischen Nutzung von Biomasse und bewerten die Konzepte

hinsichtlich der technischen, wirtschaftlichen und ökologischen Darstellbarkeit. Am Ende des Seminars findet eine Abschlussveranstaltung mit gemeinsamer Präsentation der ausgearbeiteten Konzepte vor einer Fachjury statt.
Zudem erfolgt im Rahmen der Vorlesung eine Exkursion zu einer Biomasse-Konversionsanlage (z.B. Heizkraftwerk, Kläranlage, Vergasungskraftwerk, …). Hier können die Studenten erlernte Sachverhalte an real existierenden Anlagen wiederfinden und zur Anwendung bringen.

Media:
Vortrag, Präsentation, Handzettel, Tafelanschrieb, Online-Lehrmaterialien (Multimedia), Seminarvorträge der Studenten

Reading List:
Karl, J.: Dezentrale Energiesysteme. 2. Aufl., München: Oldenbourg Wissenschaftsverlag, 2006
Fachagentur Nachwachsende Rohstoffe (Hrsg.): Leitfaden Bioenergie - Planung, Betrieb und Wirtschaftlichkeit von Bioenergieanlagen. Gülzow, 2006
Kaltschmitt, M: - Energie aus Biomasse (2009)

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

Courses (Type of course, Weekly hours per semester), Instructor:
Energetische Nutzung von Biomasse und Reststoffen (Vorlesung, 2 SWS)
Fendt S [L], Spliethoff H, Ewald A, Fendt S, Johne P

Seminar zu Energetische Nutzung von Biomasse und Reststoffen (Übung, 1 SWS)
Johne P [L], Spliethoff H, Ewald A, Fendt S, Johne P
For further information in this module, please click campus.tum.de or here.

Module Description

WI001255: Lecture Series Renewable Energy Systems in the Global South | Ringvorlesung Erneuerbare Energiesysteme im Globalen Süden

Version of module description: Gültig ab summerterm 2020

Module Level: Master	**Language:** English	**Duration:** one semester	**Frequency:** winter semester
Credits:* 6	**Total Hours:** 180	**Self-study Hours:** 135	**Contact Hours:** 45

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

Description of Examination Method:
Written exam of 60 minutes:
- In multiple-choice questions and short questions, it is examined if the students are able to name and explain facts regarding renewable energy technologies, decentralized energy systems and their utilization and operation in the Global South correctly.
- In computational tasks, it is examined if the students are able to classify relevant location parameters correctly and perform calculations on renewable energy technologies correctly in order to design decentralized energy systems in the Global South according to the framework conditions of a certain location.
- In text tasks, it is examined if the students are able to classify and evaluate technological, economic and social factors influencing renewable energy technologies, decentralized energy systems and their utilization and operation in the Global South correctly.
- The exam is graded.
- Up to 20% of the exam can be multiple-choice questions.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
- Bachelor degree in an engineering study program or a study program, which included technological/engineering aspects (such as B.Sc. Management & Technology)
- Interest in various renewable energy technologies, decentralized energy systems and their utilization and operation in the Global South
- Interest in the socio-economic factors influencing the utilization of renewable energies in the Global South

Content:
Overview of renewable energy technologies including their functionality, their technological and economical assessment, their integration in decentralized energy systems as well as business concepts for their utilization in the Global South:
- Renewable energy systems in the Global South - Why and how?
- Small-scale solar thermals and photovoltaics
- Small-scale hydro-power
- Small-scale wind-power
- Small-scale biogas systems
- Battery storages
- Electrical components of mini-grids
- Rural electrification planning through Geo Information Systems
- System sizing through least-cost modelling
- Sustainable energies and entrepreneurship in the Global South
- Sustainable enterprises for Renewable Energies in the Global South
- Rural electrification projects in the Global South

Intended Learning Outcomes:
After successfully completing the module, students are able to
- Name and explain facts regarding renewable energy technologies, decentralized energy systems and their utilization and operation in the Global South.
- Perform calculations regarding renewable energy technologies in order to be able to design decentralized energy systems in the Global South.
- Classify and evaluate technological, economic and social factors influencing renewable energy technologies, decentralized energy systems and their utilization and operation in the Global South.
- Develop concepts for decentralized energy systems in the Global South based on the technological, economic and social framework conditions of a certain location.

Teaching and Learning Methods:
Lectures and presentations by various researchers from TUM as well as entrepreneurs and other experts from the field of Renewable Energies in the Global South.
In exercise lessons, the taught knowledge of the lectures are applied to exemplary topics. After each lecture, the students conduct these exercises in homework and afterwards, these are discussed during the upcoming exercise lesson. Most of these exercises are calculating tasks about the technical components, but there are also some exercises regarding the financial assessment of renewable energy technologies. The exercises are not graded.

Media:
The following media types are used:
- Computer-aided presentations for the lectures
- Exercises
- Discussion of provided literature

Reading List:
- Presentation slides of the speakers
- Solutions of exercise lessons
- Other literature recommended by the speakers

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

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

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

Skill Area - Building Physics and Energy Efficiency | Kompetenzfeld - Bauphysik und Energieeffizienz

Module Description

AR30471: Science in Cultural Heritage | Science in Cultural Heritage

Interdisciplinary thinking

Version of module description: Gültig ab winterterm 2021/22

Module Level: 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:
The examination performance takes the form of a presentation (oral exam).
The duration of the presentation is 20 minutes followed by a discussion of a maximum of 10 minutes. A selection of possible topics will be announced in Moodle in the first weeks of the semester. The presentation of a topic of your choice is also possible, but only in coordination with the Chair.

The delivery of the "presentation" is to assess the ability to understand a technical/scientific subject, to analyze and evaluate facts and factors of influence, to summarize the subject and present it to an interdisciplinary audi-ence, and to stand a discussion about the presented subject.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Bachelor's degree in technical physics, chemistry, engineering or architecture
Basic knowledge of material science, chemistry and physics.

Content:
The seminar “Science in Cultural Heritage. Interdisciplinary thinking” has the goals to introduce the students to the discipline of Heritage science. Heritage science means the science and technologies of understanding and conserving the objects of our heritage such as documents, paintings, sculptures, and buildings. The physics, chemistry and material-science understanding of these objects and of measuring devices, the biology of organ-isms that can cause degradation, the

understanding of the climate and environment – all of these contribute to the short- and long-term strategies for preservation.

The seminar block intends to introduce the students to the field of Heritage Science throughout the presentation of specific research topics presented by researchers of the TUM as well as professionals working in the field in external research institutions. The seminar intends to show the interdisciplinary interaction of natural sciences and engineering with the humanities and social sciences.
Hot topics to be covered by the Seminar:
• Archaeometry;
• Characterization techniques;
• New materials and methodologies;
• Multi-scale imaging;
• Monitoring and remote sensing;
• Dating and authenticity;
• Alteration and ageing;
• Case studies;

Intended Learning Outcomes:
At the end of the module students
• are able to understand why it so important to conserve our cultural heritage, and to do research on ma-terials used in the past.

• The students acquire detailed and differentiated knowledge about materials of historical and artistical in-terest and their physico-chemical behaviour.

• They learn more about the materials used in the past and understand the importance of such knowledge also for the development of new sustainable products.

• They also learn about the meaning and importance of an interdisciplinary approach in research.

• The students will be able to understand the analytical challenges and boundary conditions in the stud-ies of valuable and highly heterogeneous objects/surfaces.

• The students learn about the state-of-the-art technology that is currently applied and developed for Cul-tural heritage studies and they will be able to evaluate the potentials and limitations of such methods for different applications and disciplines.

• They learn about current research topics and will be able to critically evaluate research queries.

Basic principles of chemistry and physics will be refreshed.

Teaching and Learning Methods:
- Self-study (learning) of technical terms and basic interrelations;

- Supplementing and refreshing basic concepts of physics and chemistry;

- In-depth discussion of lecture topics and case studies;

- Intensive discussion, preparation and further communication of topics in Heritage science;

- Understanding of the potentials of the research of this discipline for correlated fields.

Media:

Reading List:
Andreas Burmester, Der Kampf um die Kunst. Max Doerner und sein Reichsinstitut für Maltechnik (Schriften der Bayerischen Staatsgemäldesammlungen und des Doerner Institutes), 2016. SBN 978-3-412-50376-5
Mauro Matteini, Rocco Mazzeo, Arcangelo Moles, Chemistry for restoration. Painting and restoration materials. Nardini (1 Oct. 2016) ISBN-13:978-8840444505
Rocco Mazzeo, Aldo Roda and Silvia Prati, Analytical chemistry for cultural heritage: a key discipline in conser-vation research. Anal Bioanal Chem (2011) 399:2885–2887. DOI 10.1007/s00216-011-4672-5
Dorothy Mahon, Silvia A. Centeno , Margaret Iacono, Federico Caró, Heike Stege and Andrea Obermeier. Jo-hannes Vermeer's Mistress and Maid: new discoveries cast light on changes to the composition and the dis-coloration of some paint passages. Heritage Science (2020) 8:30 https://doi.org/10.1186/s40494-020-00375-2
Silvia A. Centeno , Charlotte Hale, Federico Carò, Anna Cesaratto, Nobuko Shibayama, John Delaney,Kathryn Dooley, Geert van der Snickt, Koen Janssens and Susan Alyson Stein, Van Gogh's Irises and Roses: the con-tribution of chemical analyses and imaging to the assessment of color changes in the red lake pigments. Herit-age Science (2017) 5:18. DOI 10.1186/s40494-017-0131-8
Federico Carò, Elena Basso and Marco Leona, The Earth Sciences from the Perspective of an Art Museum, Elements, (2016) 12: 33–38. DOI: 10.2113/gselements.12.1.33

Responsible for Module:
Sessa Clarimma Clarimma.sessa@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Science in Cultural Heritage (Interdisciplinary thinking) (Seminar, 2 SWS)
Sessa C, Danzl T, Große C
For further information in this module, please click campus.tum.de or here.

Module Description

BGU44013T2: Computation in Engineering I | Computergestützte Berechnungsverfahren in den Ingenieurwissenschaften I

Version of module description: Gültig ab summerterm 2020

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 written exam (90 min) and a piece of work in the form of an exercise, with which the programming knowledge of the students is tested.

Within the scope of the study performance, the students present their exercise performance, a program for calculating a pipe network. With the independently completed programming task and the approx. 15 min. oral presentation of this, in which the individual program steps are explained, the students prove that they have understood the essential aspects of how to create a complex object-oriented program and that they are able to develop such a comprehensive program themselves. The exercise must be passed.
The exam should prove that the essential concepts of computer-aided calculation methods are understood in engineering. Among them the object-oriented modelling with conversion in C++, the mathematical bases for the representation of curves as well as the different methods for the modelling of geometrical objects in CAD systems. No aids are allowed in the exam.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Prerequisite for a successful participation are basics of engineering informatics, which include the content of the modules 'Building and Environmental Informatics I (BGU65004)' and 'Building and Environmental Informatics II (BGU44011)'. In particular, it is necessary to master the basics of any programming language (data types, control structures, functions).

Content:
- object oriented modeling with Unified Modeling Language (UML)
- transferring UML to C++

- automatic and static objects, structures, classes, polymorphism, inheritance
- sets, relations and graphs
- principles of geometric modeling
- direct and indirect representation schemes
- Space trees such as octrees
- vertex-edge-face(vef)-graphs, efficient data structures
- winged-edge data structure for BoundaryRepresentation-models
- Euler-operators
- geometrical an mathematical representation of curves
- approximation of points with the method of least squares
- implementation schemes in two dimensions
- cubic splines
- Bezier-curves
- B-splines

Intended Learning Outcomes:
After the participation in the module, the students are able to:
- describe and implement technical processes algorithmically
- develop object-oriented software of moderate complexity in C++
- to assess the advantages and disadvantages of the methods used in CAD systems to model three-dimensional geometric objects (BRep, CSG, octal trees)
- to apply the mathematical basics of the splines and B-splines frequently used in computer-aided geometry for the representation of curves

Teaching and Learning Methods:
The module consists of a lecture and an accompanying central exercise. In the exercise, the methods developed in the lecture are implemented in C++. The necessary programming techniques are taught in the lecture. Some tasks to assess the learning progress, will be programmed in the lecture after the taught material. The solutions will be presented and discussed in the following week.
The lecture and the exercise take place in the computer rooms of the faculty, so that own notes can be inserted immediately into the on-line available lecture material and the exercise material can be converted at own program examples. All presentation documents, tasks, solutions etc. can be downloaded from the website with the handwritten supplements of the respective lecturer (tablet PC) after the respective course to support self-study.

Media:
PowerPoint as well as the white board

Reading List:
Daoqi Yang: C++ and object-oriented numeric computing for Scientists and Engineers, Springer-Verlag 2001. A sufficient number of copies is in stock at the university library. Additionally, print out copies of the manuscript and lecture notes are available from the lecturer.

Responsible for Module:
PD Dr.-Ing. habil. Stefan Kollmannsberger

Courses (Type of course, Weekly hours per semester), Instructor:
Computergestützte Berechnungsverfahren in den Ingenieurwissenschaften I (Vorlesung, 2 SWS)
Kollmannsberger S

Übung zu Computergestützte Berechnungsverfahren in den Ingenieurwissenschaften I (Übung, 1 SWS)
Kopp P
For further information in this module, please click campus.tum.de or here.

Module Description

BGU62053: Sustainable Lighting | Nachhaltige Lichttechnik

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
The module exam consists of a written exam. The aim of the written exam is verify to what extent participants have achieved the learning objectives. The latter are both module-related and competence-oriented. The duration of the written exam is 90 min. No aids are allowed with the exception of a calculator. The aim of the written exam is to test, in an application-oriented way, whether students included the use of sustainable lighting concepts in the planning process. Important: Tthe exam will take place online via Moodle. The exam is not proctored, all aids are allowed.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
keine

Content:
The foundations of the physiological and psychological perception of light are taught (colour of light, colour reproduction, direct and indirect effects of light). In addition, the photometric laws and the parameters and units of lighting technology are conveyed. The priority is always the aspect of sustainable lighting technology. Daylight-dependent design as well as foundations of lamp and lighting technology are imparted, as well as the foundations of assessing simulation tools.

Intended Learning Outcomes:
After completing this course successfully, students are able to
- understand foundations of lighting, including the basics of photometry, the perceptive function of the eye, artificial lighting technologies (lamps, lights, operating units), and daylight technology
- apply daylight technology, taking account of issues related to interior and façade design as well as the integration of artificial lighting systems

- understand the foundations of planning artificial lighting systems and natural lighting
- familiarise themselves with calculation methods (light simulation methods for artificial and natural light) and assessment methods (glare and energy)
- understand the basic functions of the eye as well as factors that have an effect on the visual function and perception
- understand the foundations of light and the environment: energy, sustainability, EU directives
- analyse tools, variables of lighting, lighting materials.

The students are able to perceive and interpret the links and the tensions between persons, light and space. They know the basic technical concepts of lighting and know how to use them.

Teaching and Learning Methods:
The course is held in the form of a classical lecture, part of which in a block. Lectures, presentation and blackboard work, experiments on photometric parameters are presented. Excursions are planned.

Media:
Lecture slides, PowerPoint presentation, demonstration, software-based work on a case study, computer-assisted presentation for the lecture, lecture script, experiments on photometric parameters

Reading List:
Gall, Dietrich: Grundlagen der Lichttechnik : Kompendium. 2. überarb.. München: Pflaum, 2007.
Ulmann, Philippe P.: Licht und Beleuchtung : Handbuch und Planungshilfe. Berlin: DOM publishers, 2015.
Hentschel, Hans J: Licht und Beleuchtung : Theorie und Praxis der Lichttechnik. 4. Aufl.. Heidelberg: Hüthig, 1994.

Responsible for Module:
Werner Lang sekretariat.enpb.bgu@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Nachhaltige Lichttechnik (Vorlesung, 4 SWS)
Lang W [L], Meier-Dotzler C, Schwering K
For further information in this module, please click campus.tum.de or here.

Module Description

BGU62054: Numerical Simulationmethods for Sustainable Planning | Numerische Simulationsmethoden der Nachhaltigkeitsplanung

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
The module examination consists of an exercise performance incl. Presentation which has to be uploaded on Moodle. Students submit 10-15 exercise sheets to the simulation programs covered in the module. They show that they have gained knowledge of the specific simulation programs and their application. In particular, they must demonstrate that they can use the simulation programs to perform various processes, e.g. in buildings and optimize for specific problems, e.g. the increase in energy efficiency by reducing the heating energy requirement. In addition, the students demonstrate that they are able to solve detailed simulation tasks, which they use to analyze various tools and to further interpret the complex results in terms of sustainability

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Previous knowledge in handling simulation programs

Content:
The Module gives an introduction to basic theoretical and practical knowledge in numerical simulationmethods and their use in building planning and the sustainable improvement of constructional products. During the module, various simulation programs for steady-state and transient calculation methods for building planning are introduced. All fundamental principles are explained and applied on a specific exmaple. Thematic areas are climate analysis, climate-adapted planning, thermal building physics, energy requirement statement, life cycle assessment, user behavior and calculation of thermal bridges. A special focus is the application of results into planning processes which will be demonstrated and exercised by various example projects.

Intended Learning Outcomes:
After attending this module students are able to apply various tools of numerical simulation and contribute the results concerning planning processes. Therefore basic theoretical and practical knowledge regarding the use of various simulation applications is taught. Based on these basic principles, the students are able to implement their software knowledge into the different planning processes to analyse the results concerning sustainability. Furthermore, the students are able to analyse the results concerning the reasonableness and depending on the given context, evaluate the use of various applications.

Teaching and Learning Methods:
Each thematic area starts with a lecture concerning the theory of each application tool and their function. In the following this knowledge will be consolidated by exercises and seminar reports. Consequently, the analysis of the results concerning reasonableness as well as implementing tools into planning processes are taught. To maintain a certain realistic condition all assignments and exercises are conducted by a specific project.

Media:
PowerPoint, Excel, different simulation programs (TRNSYS Lite, WufiPlus, DiaLux, GaBi, ArgosPro, Rhino, Grasshopper, Diva, Ladybug)

Reading List:
[1] European Commission, Rahmen für die Klima- und Energiepolitik bis 2030 - Klimapolitik - European Commission. [Online] Verfügbar: https://ec.europa.eu/clima/policies/strategies/2030_de.
[2] COUNCIL, E. P. A. Directive 2010/31/EU of the European Parliament and of the Council of 19 May, 2010 on the energy performance of buildings. Official Journal of the European Union, 2010, S. 13-35.
[3] Bundesminsiterium für Umwelt, Naturschutz, Bau und Reaktorsicherheit, “Energieeinsparverordnung,”
[4] COUNCIL, E. P. A. Directive 2010/31/EU of the European Parliament and of the Council of 19 May, 2010 on the energy performance of buildings. Official Journal of the European Union, 2010, S. 13-35.
[5] T. Ibn-Mohammed, R. Greenough, S. Taylor, L. Ozawa-Meida, and A. Acquaye, “Operational vs. embodied emissions in buildings—A review of current trends,” Energy and Buildings, vol. 66, pp. 232–245, 2013.

Responsible for Module:
Werner Lang sekretariat.enpb.bgu@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Numerische Simulationsmethoden der Nachhaltigkeitsplanung (Seminar, 4 SWS)
Lang W [L], Banihashemi F, Schwering K, Takser I
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, Vilgertshofer S, Forth K, Fellner J, Zahedi A
For further information in this module, please click campus.tum.de or here.

Module Description

BGU65016: BIM.fundamentals | BIM.fundamentals

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

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, Vilgertshofer S

BIM.fundamentals Übung (Übung, 2 SWS)
Wu J, Memis I, Vilgertshofer S
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 2021

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 is assessed by a project with a hand-in interview. The project consists of a design of a traffic route model under consideration of the given boundary conditions. The model is developed and created independently during the semester with the help of suitable software tools. With the project, the students demonstrate that they understand the taught concepts and methods of Building Information Modelling (BIM) in traffic route construction and recognise, reproduce, and independently apply everyday use cases. In addition, within the project's scope, the students show that they can use the concepts and methods they have acquired for the structured analysis and reflection of engineering problems to develop their solution concepts. In the hand-in interview, the students present the project work results and explain their approach with regard to questions on practical software application and the boundary conditions for the selected design model within the framework of the module. In this way, the students prove that they can transparently explain their work steps and respond to and discuss technical questions regarding the software's choice and application. The hand-in discussion should not exceed 60 minutes.
The module grade consists of the project (70%) and the hand-in interview (30%).

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:

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

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

Module Description

BV110005: Seminar Building Physics | Seminar Bauphysik

Version of module description: Gültig ab winterterm 2018/19

Module Level: 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:
Proof of performance is provided by submitting a term paper at the end of the semester, which results in the grade for the module.
The aim of the elaboration is to prove that the topics developed in the course of the seminar have been understood in the context of building physics and can be reproduced in writing. IDuring the course, problems relating to a model space in building physics must be analysed and solutions must be found, implemented and documented based on the learning outcomes acquired in the module.
The production of the housework requires the scientific reproduction of learned processes and methods.
For the production of the seminar work all aids are permitted. Here special emphasis is put on scientifically correct work (in particular using correct references).

Repeat Examination:

(Recommended) Prerequisites:
- Basic understanding of building physics contexts
- Understanding planning documents
- Constructive understanding of structures and details

Building Physics Basic Module
Building Physics - Supplementary Module
Measurement techniques

Content:
Current topics of building physics: heat, moisture, noise, light, sustainability topics change every semester.

- Introduction on specific topics
- Theoretical or practical aspects of these topics
- Software instructions for specialized software if necessary

Intended Learning Outcomes:
Small and interdisciplinary teams work on todays topics in building physics. After the course students are able to create parts of planning actions on certain topics of building physics. They are able to evaluate and to analyse similar planning actions.

Teaching and Learning Methods:
Lectures and Seminar with presentations. Additional online-course and online-platform.

Media:
Powerpoint-presentations and technical literature, specialized software if necessary e.g. thermal simulation, LCA, LCC, etc.

Reading List:
Technical publications are made available adapted to the respective topics.

Responsible for Module:
Klaus Sedlbauer

Courses (Type of course, Weekly hours per semester), Instructor:
Bauphysik Seminar (Seminar, 2 SWS)
Peikos A
For further information in this module, please click campus.tum.de or here.

Module Description

BV110006: Building Physics in Practice | Bauphysik in der Praxis

Version of module description: Gültig ab winterterm 2018/19

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

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

Description of Examination Method:
Exam duration (in min.): 60.
Proof of performance is provided in the form of a written examination. The aim of the written examination is to prove that the topics presented in the course of the lecture can be compiled, have been understood, can be presented in compressed form. Therefore, problems must be analysed in a limited time and solutions must be found. This includes in particular practical building physics questions of energy, including airtightness tests, sound, humidity and lighting. The answers require own formulations, marking multiple choice answers, or own calculations. No tools are allowed except a simple calculator.

Repeat Examination:

(Recommended) Prerequisites:
- Building Physics basic Module
- Building Physics Supplementary Module

Content:
Results of recent industry developments concerning building physics tasks and their interpretation.

Intended Learning Outcomes:
After participation in the course, students will be able to understand current building physics issues in construction practice. They can analyze problems of building physics especially concerning energy, including air-tightness testing, sound, humidity and lighting.

Teaching and Learning Methods:
The course includes lectures and, if necessary, workshops with experiments or the performance of exemplary measurements.
In addition, students are provided with further information on the individual topics in an online learning room.
This enables the guest lecturers to engage an intensive exchange with the students, to answer questions promptly and personally and, if necessary, to carry out the experiments independently. These questions can then be discussed further in the online learning room and additional information on individual topics can be provided.

Media:
- Board, Powerpoint presentations.
- Experiments and workshops if necessary

Reading List:
- Kohler, St., et.al.: Energieeffizienz von Gebäuden. Wüstenrot Stiftung, Karl Krämer Verlag Stuttgart + Zürich (2006).
- Gösele, K., Schüle, W., Künzel, H.: Schall, Wärme, Feuchte. Bauverlag Wiesbaden, 10. Auflage (1997).
- von Weizsäcker, E. U., Lovins, A., B., Lovins, L. H.: Faktor vier. Doppelter Wohlstand halbierter Naturverbrauch. Droemer Knaur, München (1996).
- Bansal, N.K.; Hauser, G. und Minke, G.: Passiv Building Design. A Handbook of Natural Climatic Control. Elsevier Science B.V., Amsterdam, London, New York, Tokyo (1994).
- Hauser, G., Höttges, K., Stiegel, H. und Otto, F.: Heizenergieeinsparung im Gebäudebestand. Hrsg.: Gesellschaft für Rationelle Energieverwendung (2001).

Responsible for Module:
Klaus Sedlbauer

Courses (Type of course, Weekly hours per semester), Instructor:
Bauphysik in der Praxis (Vorlesung, 2 SWS)
Nowak S [L], Sedlbauer K
For further information in this module, please click campus.tum.de or here.

Module Description

BV110050: Sustainability of Buildings | Nachhaltigkeit von Gebäuden

Version of module description: Gültig ab winterterm 2020/21

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 examination performance is provided in the form of a seminar paper at the end of the semester. The prerequisite for this is an obligatory lecture within the framework of the seminar on the respective topic of the seminar paper. In the paper it should be proven that only with the help of cited sources tasks in the field of sustainability of buildings can be analysed and evaluated and ways to a solution can be found. The subject areas of the seminar papers and the related lectures cover the entire subject matter. This includes in particular the understanding of national and international evaluation methods for sustainable building, associated ecological, economic and social aspects as well as certification procedures. The seminar papers require suitable self-developed structures, own formulations and own content-related solutions to the tasks set.

Repeat Examination:

(Recommended) Prerequisites:
none

Content:
International evaluation methods for sustainable construction including LEED (USA), BREEAM (UK) and DGNB (Germany)
Ecological, economic and social aspects of the sustainability of buildings
Certification processes and criteria of the different systems

Intended Learning Outcomes:
After attending the course, students will be able to understand national and international assessment methods and certification procedures (DGNB, LEED, BREEAM and others) for buildings and apply the assessment of individual criteria.

Teaching and Learning Methods:
The module is held as a seminar with lectures by the teachers and learners. The teaching of competences and contents is carried out through these lectures. In addition, the interaction between teachers and learners as well as between the learners themselves is given sufficient space in the sense of scientific discussions. The written elaboration (seminar paper) serves to deepen specific questions and also to deepen competences and contents. The essential part of the self-study hours is used for the preparation of the seminar paper.

Media:
Powerpoint presentations, eTeaching

Reading List:
- Deutsche Gesellschaft für Nachhaltiges Bauen: Das Deutsche Gütesiegel Nachhaltiges Bauen, Aufbau Anwendung - Kriterien; Stuttgart (2009).
- Informationsportal Nachhaltiges Bauen des BMVBS: http://www.nachhaltigesbauen.de/
- World Green Building Council: http://www.worldgbc.org/about-worldgbc/who-we-are
- U.S.Green Building Council: LEED 2009 for New Construction and Major Renovations; Washington (2008).
- SB Alliance: The SB Alliance. A research based assessment oriented organization; Paris (2008).
- Essig, N.: Die Bemessung der Nachhaltigkeit; in db, Ausgabe 5, S. 62-65; Leinfelden Echterdingen (2009).
- BRE Global: BREEAM Offices 2008 Users Manual; Watford; 2008.
- Larson, N: Rating Systems and SBTool, The International Initiative for a Sustainable Built Environment; Seoul (2007).

Responsible for Module:
Klaus Sedlbauer

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

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

Module Description

BV360011: Building Physics in Research | Bauphysik in der Forschung

Version of module description: Gültig ab winterterm 2018/19

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

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

Description of Examination Method:
Exam duration (in min.): 60.
Proof of performance is provided in the form of a written examination. The students should prove that specific questions in the field of building physics research can be compiled, have been understood, can be presented in compressed form. This implies in particular current theoretical models in building physics. The examination questions cover the entire content of the lectures. The answers require own formulations, marking multiple choice answers, or own calculations. No tools are allowed except for a simple calculator.

Repeat Examination:

(Recommended) Prerequisites:
- Building Physics basic Module
- Building Physics Supplementary Module

Content:
Results, their interpretation and further development of current research in the field of building physics, communicated by guest speakers from different research areas. Examples and lectures focus on scientific building physics.

Intended Learning Outcomes:
After participation the students are able to develop theoretical models to describe complex processes in the field of building physics, which is an important ability for the preparation of a possible subsequent master thesis in the field of building physics.

Teaching and Learning Methods:
The course includes lectures and, if necessary, scientific workshops held by guest speakers from national and international research institutions. The content covers current research in building physics especially in thermodynamics, energy, lighting and acoustics.
Students are provided with further information on the individual topics in an online learning room. This enables the guest lecturers to engage an intensive exchange with the students, to answer questions promptly and personally and, if necessary, to carry out the experiments independently. These questions can then be discussed further in the online learning room and additional information on individual topics can be provided.

Media:
Powerpoint presentations blackboard

Reading List:
- Kohler, St., et.al.: Energieeffizienz von Gebäuden. Wüstenrot Stiftung, Karl Krämer Verlag Stuttgart + Zürich (2006).
- Gösele, K., Schüle, W., Künzel, H.: Schall, Wärme, Feuchte. Bauverlag Wiesbaden, 10. Auflage (1997).
- von Weizsäcker, E. U., Lovins, A., B., Lovins, L. H.: Faktor vier. Doppelter Wohlstand halbierter Naturverbrauch. Droemer Knaur, München (1996).
- Bansal, N.K.; Hauser, G. und Minke, G.: Passiv Building Design. A Handbook of Natural Climatic Control. Elsevier Science B.V., Amsterdam, London, New York, Tokyo (1994).
- Hauser, G., Höttges, K., Stiegel, H. und Otto, F.: Heizenergieeinsparung im Gebäudebestand. Hrsg.: Gesellschaft für Rationelle Energieverwendung (2001).

Responsible for Module:
Klaus Peter Sedlbauer

Courses (Type of course, Weekly hours per semester), Instructor:
Bauphysik in der Forschung (Vorlesung, 2 SWS)
Sedlbauer K
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, Petzold F, Pfitzner F, Vilgertshofer S
For further information in this module, please click campus.tum.de or here.

Module Description

MW0164: Energy Optimization for Buildings | Energieoptimierung für Gebäude

Version of module description: Gültig ab summerterm 2012

Module Level: Master	**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:
Die Modulprüfung ist schriftlich. Sie besteht aus zwei Teilen, einem Theorie- und einem Berechnungsteil. Der Theorieteil dauert 45 min und findet ohne zusätzliche Hilfsmittel statt. Alle Arten von Fragestellungen sind im Theorieteil möglich, sodass ein gezieltes Prüfungen von Grundlagen-, Detail- und Transferwissen möglich ist. Die Studierenden erstellen im Berechnungsteil Energie- und Mas-senbilanzen für ausgewählte Gebäudesysteme und berechnen verschiedene technisch relevante Größen und Parameter anhand von gegebenen Praxisbeispielen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Thermodynamik I

Content:
Fachliche Inhalte:
1. Energiesituation in der Bundesrepublik Deutschland
2. Innere Einflüsse
3. Klimatechnik
4. Kältetechnik
5. Bauliche Einflüsse auf den Energiebedarf von Gebäuden
6. Äußere Einflüsse
7. Doppelschalige Glasfassaden – Eine Einführung in deren thermisches und energetisches Verhalten

Fachpraktische Inhalte:

Fachübergreifende Inhalte: Einfache, ingenieurstechnische Abschätzungen rund um das Thema Energie und Leistung.
Methodische Inhalte: Ingenieurtechnische Herangehensweise an Problemstellungen zum Thema Energieverbrauchsabschätzungen für Gebäude

Intended Learning Outcomes:
Nach erfolgreicher Teilnahme an diesem Modul sind die Studierenden in der Lage die Energiesituation in Deutschland und speziell in Gebäuden zu bewerten. Auf Grundlagenwissen wird im Rahmen des Moduls sehr viel wert gelegt, wozu Einheiten thermodynamischer Größen genauso gehören wie beispielsweise der Energiegehalt eines Liter Öls; dies erlaubt den Studierenden auch über das Fach hinaus, sehr schnell thermodynamische Abschätzungen zu entwickeln und übergeordnete Zusammenhänge zu verstehen. Das Modul greift Grundlagenwissen aus anderen Modulen wie der Thermodynamik und des Wärmetransportes auf und gibt dem Studierenden so die Möglichkeit das erlangte Wissen anzuwenden und eigene Ideen auch in Richtung Energieoptimerung für Gebäude zu entwickeln. Ein tiefgreifender Einblick in das Thema Energiebilanz von Gebäuden, Wärmeübertragungsmechanismen in Dämmsystemen und Verglasungen, sowie der Thermodynamik von Klima- und Kältetechnik-Systemen hilft den Studierenden zu verstehen, die Energiesitauation von Gebäuden ganzheitlich und kritisch zu bewerten. Schwerpunkt der Vorlesung ist die Erlangung des ingenieurstechnischen Handwerkszeugs für die Entwicklung und Bewertung von Wärmedämmsystemen, Verglasungstechniken und Raumtechnischen Lüftungsanlagen. Ein besonderer Wert wird dabei auf den Einfluss auf den Energieverbrauch der einzelnen Systeme auf ein Gebäude gelegt. Der Bezug zur Praxis wird durch die Teilnahme an einer Exkursion verstärkt.

Teaching and Learning Methods:
Vortrag, Multimediapräsentationen.

Media:
Vortrag, Folienanschrieb, Präsentation, Vorlesungsskript, Vorlesungsfolien, Übungsskript, alte Prüfungsaufgaben

Reading List:
Das Vorlesungsskript ist ausreichend

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

Courses (Type of course, Weekly hours per semester), Instructor:
Übung zu Energieoptimierung für Gebäude (Übung, 1 SWS)
Polifke W [L], Spinnler M

Energieoptimierung für Gebäude (Vorlesung, 2 SWS)
Polifke W [L], Spinnler M
For further information in this module, please click campus.tum.de or here.

Module Description

MW0628: Energy and Economy | Energie und Wirtschaft

Version of module description: Gültig ab winterterm 2020/21

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

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

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

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

Repeat Examination:
Next semester

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

Content:
The lecture “Energy and Economics” deals with current issues of energy supply, economics and social impacts. Since the fundamental energy generation technologies are not in the main focus, it is recommended to attend lectures like “Energy Systems” in advance. The lecture and the exam is held in German language. Involving external experts from industry the following topics are presented and discussed:
- Fundamentals of energy supply
- Commodity markets and world trade in primary energy

- Power trading
- Energy conversion concepts
- Methods of economic calculation
- Efficiency factors of power plants
- Governmental intervention in the market and liberalization
- Importance of energy-intensive companies to the economy
- Heat generation and supply
- Emissions and related costs
- Requirements for future energy systems

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

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

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

Reading List:
General literature will be announced in the lecture.

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

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

Skill Area - Constructional Engineering and Lifecycle Engineering. | Kompetenzfeld - Bautechnik und Life Cycle Engineering

Module Description

WZ4206: Material Flow Management and Applications | Material Flow Management and Applications

Version of module description: Gültig ab winterterm 2018/19

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 research paper of around 12-15 pages which is the means to evaluate whether the students have understood and whether they are able to apply the methodology of material flow management on a case study in a scientifically manner and to create an own scientific paper about concepts for material flow management and treatment of materials based on the methodologies of material flow analysis and life cycle assessment. management and treatment of materials based on the methodologies of material flow analysis and life cycle assessment.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
knowledge in natural science (biology, chemistry, ecology, physics);
understanding for engineering science and also for social/cultural aspects.

Content:
The students acquire detailed and differentiated knowledge about the following topics:
- need of material flow management
- procedure of material flow management
- material and substance flow analysis
- material flow assessment by sustainability indicators
- life cycle assessment
- development of strategies and measures for material flow management

(e.g. resource efficiency, urban mining, industrial ecology, bio-economy, circular economy).

Intended Learning Outcomes:
By the means of the module the students are able to:
- understand the necessity of material flow management
- understand the relationships between different processes, technological treatments of materials and organizational measures
- apply the procedure of material and substance flow analysis
- apply the assessment methods of indicator systems and life cycle assessment
- create concepts for material flow management and treatment of materials.

Teaching and Learning Methods:
Concerning teaching methods, lecture and presentation parts provide the theoretical foundation of materials flow management. Real case studies are introduced to the students and worked out in the class. Likewise within interdisciplinary projects in reality, the students have to define and to solve problems collaboratively in group work by studying specialist literature and data sources. At the end they have to create a research paper as homework about this topic. The students are supervised by tutorials by the lecturer.

Media:
Power point presentation, lecture sheets, case studies of material and substance flow analysis and life cycle assessment.

Reading List:
Brunner, P.H., Rechberger H. (2004): Practical Handbook in Material Flow Analysis. Advanced Methods in Resource and Waste Management. Lewis Publishers, Boca Raton, pp. 318.
Brunner, P.H.; Rechberger, H.; 2016: Handbook of Material Flow Analysis: For Environmental, Resource, and Waste Engineers. Taylor & Francis Inc; 2. Revised Edition, pp. 453
Weber-Blaschke, G.; 2009: Stoffstrommanagement als Instrument nachhaltiger Bewirtschaftung natürlicher und technischer Systeme. Ein kritischer Vergleich ausgewählter Beispiele. Schriftenreihe „Nachwachsende Rohstoffe in Forschung und Praxis“ des Wissenschaftszentrums Straubing, Bd. 1, Verlag Attenkofer, Straubing, 330 S.

Responsible for Module:
Prof. Dr. Gabriele Weber-Blaschke - Lehrstuhl für Holzwissenschaft Hans-Carl-von-Carlowitz-Platz 2, 85354 Freising; 08161/71- 5635; weber-blaschke@hfm.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Material Flow Management and Application (Vorlesung, 3 SWS)
Weber-Blaschke G [L], Weber-Blaschke G
For further information in this module, please click campus.tum.de or here.

Module Description

AR17042: Repair of Historic Supporting Structures | Historische Tragkonstruktionen des industriellen Zeitalters

Version of module description: Gültig ab summerterm 2022

Module Level: Master	**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:
Knowledge to be achieved is questioned in a presence test with a limited duration of 60min. Questions on various topics should be answered and solved in either writing and/or through multiple choice questions. The students are assessed by their ability to comprehend, explain and present the construction, material science relationship and load bearing behaviour of historic structures.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Recommended requirements are a basic knowledge of:
- construction history
- statics and mechan ics of materials
- building structures

Content:
We take a look at historic structures made of masonry, timber and especially iron or steel and reinforced concrete. We analyse the load-bearing behaviour of specific constructions qualitatively and quantitatively.

Intended Learning Outcomes:
At the end of the module, students are able to understand the geometry and function of historic structures, especially historic industrial structures. They can analyze and differentiate constructions regarding their building age and

used materials. Furthermore, students will be able to assess the qualitative and quantitative load bearing mechanisms of those constructions.

Teaching and Learning Methods:
The basics and case studies are provided by lectures and corresponding scripts, and specific guest lectures. Certain abstracts of lectures are provided. Additionally, exercises are done independently and discussed within seminars.
Mandatory excursions are also undertaken.

Media:
Lecture, scripts, lecture abstracts (presentation documents), exercise papers

Reading List:
Hart, Franz: Kunst und Technik der Wölbung, München 1965. Graefe, Rainer: Zur Geschichte des Konstruierens, Stuttgart 1985. Mainstone, Rowland: Developments in Structural Form, Oxford 1998. Binding, Günther: Das Dachwerk, München 1991. Rehm, Jörg: Eisenbeton im Hochbau bis 1918, München 2019.

Responsible for Module:
D'Acunto, Pierluigi; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Historische Tragkonstruktionen des industriellen Zeitalters (Seminar, 2 SWS)
Rehm J, Tutsch J
For further information in this module, please click campus.tum.de or here.

Module Description

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

From tree to architecture – the value chain of wood

Version of module description: Gültig ab winterterm 2018/19

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

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

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

Length: 90 min.
Tools: dictionary

Repeat Examination:

(Recommended) Prerequisites:

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

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

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

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

Media:
Presentations of the lectures will be provided for the exam prepartions. Personal notes during the lectures are required and necessary to pass the test.
The online-platform "Moodle" will be created and used to exchange information and documents.

Reading List:
H. Kaufmann, W.Nerdinger: 'Bauen mit Holz - Wege in die Zukunft' Ausstellungskatalog Pinakothek der Moderne, Prestel München 2011 ISBN 978-3-7913-5180-3

Responsible for Module:
Huß, Wolfgang

Courses (Type of course, Weekly hours per semester), Instructor:
Ringvorlesung TUM.wood (Vom Baum zum Haus - Die ganze Wertschöpfungskette Holz) (Vorlesung, 2 SWS)
Seidl R, Annighöfer P, Richter K, van de Kuilen J, Benz J, Zollfrank C, Winter S, Birk S, Nagler F, Dörfler K, Ludwig F, Schuster S, Niemann A
For further information in this module, please click campus.tum.de or here.

Module Description

BGU35013: Basics of Service Life Design, Protection and Rehabilitation of Reinforced Concrete Stuctures | Grundlagen der Lebensdauerbemessung und Instandhaltung von Massivbauwerken

[Principles of life-cycle design and maintenance of structures]

Version of module description: Gültig ab winterterm 2013/14

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** 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:
In the 60-minute written examination, students demonstrate how far they understand and are able to describe concisely, in a limited time, the principles of life cycle design and maintenance of structures and are able to draw up inspection and maintenance schedules. The examination is divided into questions which require independently worded answers, and arithmetical problems. Apart from a numerical pocket calculator, no aids are allowed.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Bachelor of Civil Engineering or Bachelor of Environmental Engineering, in particular, the lecture "Construction Materials in Civil Engineering".

Content:
Life-cycle design:
- Description of the design concept (probabilistic safety concept)
- Safety requirements (limit state of serviceability and load-bearing capacity)
- Carbonation model
- Model for describing the chloride penetration process
- Design examples

Maintenance of structures:
- Protection and repair of reinforced concrete structural members
- Standards, guidelines and directives
- Building survey and assessment methods

- Protection principles
- Preparing the concrete substrate and replacing damaged concrete
- Surface protection systems and waterproofing/seals
- Electrochemical methods
- Treating cracks and voids
- Structural maintenance and monitoring
- Repair experience (case studies)

Intended Learning Outcomes:
Following successful completion of the module, students have fundamental knowledge of life cycle design. After attending the "life cycle design" lecture they are able to appreciate new buildings with regard to selected durability-restricting environmental effects and to predict the respective fitness for purpose of existing buildings.
In "Maintenance of structures" the students learn about methods of analysing damage to reinforced and prestressed concrete structures. After the lecture they are able to create strategies to avoid damage, to assess methods to correct structural damage permanently and to implement suitable repair concepts.

Teaching and Learning Methods:
The module is primarily a classic lecture with continuous support in the form of a PowerPoint presentation, through which the students can benefit directly from the experience of the lecturer. Some demonstration materials are used and passed around for improved presentation of the facts. Films of tests and methods will be integrated for improved understanding. Calculation examples are performed on overhead slides or on the board, also involving the students.

Media:
Script, power-point presentation, board work, overhead-projector, video

Reading List:
A list of the literature is handed out at the beginning of the lecture.

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

Courses (Type of course, Weekly hours per semester), Instructor:
Grundlagen der Lebensdauerbemessung und Instandhaltung von Massivbauwerken (Vorlesung, 3 SWS)
Gehlen C, Osterminski K
For further information in this module, please click campus.tum.de or here.

Module Description

BGU36006: Sustainable Development | Grundlagen der Nachhaltigkeit

Version of module description: Gültig ab summerterm 2022

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 examination performance is provided in the form of a seminar paper at the end of the semester. The prerequisite for this is an obligatory lecture within the framework of the seminar on the respective topic of the seminar paper. In the paper it should be proven that only with the help of cited sources tasks in the field of sustainable development can be analysed and evaluated and ways to a solution can be found. The subject areas of the seminar papers and the related lectures cover the entire subject matter. This includes in particular the understanding of knowledge and strategies for sustainable development including global, European and regional aspects. The seminar papers require suitable self-developed structures, own formulations and own content-related solutions to the tasks set.

Repeat Examination:

(Recommended) Prerequisites:
none

Content:
Basic knowledge and strategies for sustainable development.
The main focus is on
- global, European and regional aspects (theoretical and practical approaches)
- strategies for sufficiency and/or efficiency with their adaption to the built environment
- effects on daily life, work, studies, etc. with adaptions of ecological, economic and social aspects

Intended Learning Outcomes:
At the end of the module students are able to understand and analyse the national and international approaches of sustainability (the interrelationship of social, ecological and economical aspects) and to create possible starting points of sustainable development.

Teaching and Learning Methods:
The course is held in the form of lectures with seminar elements, e. g. in the form of scientific discussions and short written summaries (wrap-ups). In addition, further information on the individual subject areas will be made available to students in an eLearning platform.
This enables an intensive exchange with the students including answering questions promptly within the framework of the lectures and via the eLearning platform.

Media:
powerpoint, projector, eTeaching

Reading List:
- Weizäcker v.: Faktor 4. Doppelter Wohlstand - halbierter Naturverbrauch;München (1996).
- Bundesministerium für Umwelt, Klimaschutz und Reaktorsicherheit: Protokoll von Kyoto zum Rahmenübereinkommen der
- Vereinten Nationen über Klimaänderungen; Kyoto (1997).
- Deutscher Bundestag: Abschlußbericht der Enquete-Kommission "Schutz des Menschen und der Umwelt - Ziele und Rahmenbedingungen einer nachhaltig zukunftsverträglichen Entwicklung" des 13. Deutschen Bundestages: Konzept Nachhaltigkeit. Vom Leitbild zur Umsetzung, Bonn (1998).
- Lang.: Ist Nachhaltigkeit messbar? Eine Gegenüberstellung von Indikatoren und Kriterien zur Bewertung nachhaltiger Entwicklung unter Berücksichtigung der Rahmenbedingungen in Deutschland und Frankreich; ibidem - Verlag; Stuttgart (2003).
- www.nachhaltigkeitsrat.de; www.nachhaltigesbauen.de

Responsible for Module:
Klaus Peter Sedlbauer

Courses (Type of course, Weekly hours per semester), Instructor:
Grundlagen der Nachhaltigkeit (Vorlesung, 2 SWS)
Schuster H
For further information in this module, please click campus.tum.de or here.

Module Description

BGU37019T2: Seminar - Ecology in Building and Construction | Seminar Ökologisches Bauen

Version of module description: Gültig ab summerterm 2022

Module Level: 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:
The students work in teams of two self-dependently on relevant problems and compile a written report. The report examines the extent to which the students are able to present the obtained information and technical contexts scientifically in writing. The paper should comprise approx. 20 pages and will be graded. The papers will be made available to all course participants afterwards. In addition, a peer review of a draft version of the paper will be carried out by all students during the semester. Through the peer review process, students receive feedback on preliminary versions of their reports during the semester. The peer review also gives students an insight into an additional topic and into alternative approaches to implementing and structuring the paper and increases their ability to give a critical but constructive feedback. By carrying out a peer review instead of a correction by the lecturer, a change of perspective is initiated, which enhances the motivation and learning outcome of the students. The peer review is assessed as a compulsory but ungraded course achievement.
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Repeat Examination:
Next semester

(Recommended) Prerequisites:
Completed bachelor's degree in civil or environmental engineering, architecture, or similar engineering fields or natural sciences.
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Content:
• Introduction to the topics of sustainability, ecology and climate change with reference to the building industry
• Current challenges of ecological constructions

• The life cycle of building materials and structures
• Content-related and methodological basics of life cycle assessments (LCA)
• Forms of recycling for building materials, components and constructions
• Assessment of the environmental and health compatibility of building materials, components and constructions
• Consideration of the processes and procedures of life cycle assessment methods in general (life cycle inventory, impact assessment, etc.)
• Application of life cycle assessment tools to assess the sustainability of building materials, components and constructions, but also (de-)construction processes referring to national and international assessment methods
.

Intended Learning Outcomes:
Upon completion of the module, students are able to:
• classify essential environmental impacts and their evaluation criteria of selected building materials, components and constructions over their entire life cycle
• assess national and international standards and methods for life cycle assessment in the building industry and apply life cycle assessment tools where appropriate
• critically assess a specific topic on the basis of current literature and compile it scientifically in written form for an expert group of readers of fellow students and the lecturers
• critically analyse an unknown topic through the peer review process and provide constructive, fair feedback and use this for improvement of their own report
.

Teaching and Learning Methods:
Following an introductory session and the choice of topics, meetings with the lecturers take place to discuss literature research, problem analysis, structuring the results and evaluation criteria. During these discussions, the lecturers provide support in the preparation and elaboration of the written work. The focus is on the introduction to scientific work in general, as well as on the basics for the design and structure of a written report. This takes place in individual discussions in order to be able to specifically address the individual questions of each student.
In addition to the meetings with the lecturers, a peer review is carried out during the semester. For the peer review, the groups are each provided with a draft report of another group for assessment. The assessments are then communicated to the respective authors in writing. Through the peer review process, students should have the opportunity to critically analyse other people's work and to give constructive, fair feedback and use this for the improvement of their own report.
The seminar-based outline of the module enables students to independently design, reflect and expand their own learning process. In addition, students improve their abilities to work cooperatively and responsibly in groups as well as to present complex subject-related content clearly and in a target group-oriented manner in a written format.
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Media:
• PowerPoint presentations (content: pictures, illustrations of mechanisms, diagrams)

• Individual meetings with the lectuerer (in presence or online)
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Reading List:
The recommended literature depends on the chosen topic and will be discussed individually with each group during the meetings.
.

Responsible for Module:
Machner, Alisa; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
Seminar Ökologisches Bauen (Seminar, 2 SWS)
Machner A, Heisig A
For further information in this module, please click campus.tum.de or here.

Module Description

BGU51011: Special Topics in timber engineering and building construction | Sonderthemen aus Holzbau und Baukonstruktion

Version of module description: Gültig ab winterterm 2017/18

Module Level: Master	**Language:** German	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 3	**Total Hours:** 90	**Self-study Hours:** 75	**Contact Hours:** 15

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

Description of Examination Method:
The module's achievement will be a written project work with an oral presentation.
The project work shows the ability of the students to understand functional coherences and to apply important aspects of structural design and building construction. The students will be able to analyze their results and to judge
own conceptual patterns and developments. The evaluation of the written thesis takes into account the way the research was conducted and degree the goals are reached, considering the type of the work and complexity of the task definition (own contribution, self-reliance, time management, innovation of work), the content of the work (correctness of content, appropriateness of selected methodology, comprehensibility of conclusions, critical assessment of results, reflection of open questions), and formal aspects (structuring of work, orthography, quality of layout and figures, distinction of own and other work, correct citations, up-to-dateness of references). In the concluding presentation rhetorical and presentational skills, appearance and time management will be tested.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic lectures of the chair of timber structures and building construction

Content:
There will always emerge specific questions in the field of praxis and research, considering the field of applied studies of building construction and timber structures. These specific topics will be developed and worked on independently or in small groups. The main tasks lies in the development of implementation, solution and further development of these questions regarding the field of building construction and timber structures.

Intended Learning Outcomes:
In this module students learn how to summarize interdisciplinary knowledge with a specific task and to apply their accumulated knowledge. After passing this module students will be able to analyze questions in the field of building construction and timber structures independently as well as to use a scientific approach. They will be able to evaluate the results and to develop an own presentation. Furthermore they will learn important aspects of rhetoric, appearance, presentation style and time management.

Teaching and Learning Methods:
The project work will be accompanied by regular consultation hours with the advisor and elaborated personally at home. It includes literature research, employment of appropriate methods to perform the scientific work, and the written documentation and discussion of the results.

Media:
Presentations, poster, literature

Reading List:
Independent literature research

Responsible for Module:
Stefan Winter

Courses (Type of course, Weekly hours per semester), Instructor:
Sonderthemen aus Holzbau und Baukonstruktion (Seminar, 2 SWS)
Winter S [L], Winter S, Kurzer C, Merk M, Henke K, Flexeder N
For further information in this module, please click campus.tum.de or here.

Module Description

BGU51039: Advanced Building Construction RNB | Baukonstruktion Vertiefung RNB

Version of module description: Gültig ab winterterm 2018/19

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

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

Description of Examination Method:
After participating in the supplementary module 'Advanced Building Construction RNB', students will be able to characterize, implement and apply the basic functional principles of development and design of building construction and construction details. They will be able to detect and to apply the criteria for a sustainable and functional decision-making process for an optimal choice of building materials, components and elements as well as depict the interdependencies between the building and user. Fixed working periods support the students' time management skills and enable an examination of the comprehension and learning process not just the level of knowledge at a certain time.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Baukonstruktion und Tragwerkslehre 1
Baukonstruktion und Tragwerkslehre 2

Content:
The module 'Advanced Building Construction RNB' is composed of the two courses 'Principles in Building Construction' and 'Planning and Development of Construction (RNB)' that take place during winter semester. The main goal of the module is to create an understanding for the necessity to weigh and integrate interdisciplinary requirements and interdependencies of the building construction during the design process. For this, the students require the ability to think in complex ways and a fundamental understanding of functional principles and their consequences as well as the criteria for decision-making and evaluation processes.

The course 'Principles in Building Construction' aims to supplement and to deepen the knowledge gained in 'Building Construction and load-bearing Structures 1 and 2' and to teach the application of different principles of building construction. The course content can be divided into the following:
- interdependencies of the safety principles of building construction
- basics of joining and design of detailed solutions
- extended criteria for the choice of building materials, building components and construction types
- interaction and feasibility of production and assembling processes
- architectural principles of building construction
- interaction between people and buildings
- interaction and responsibility between environment and buildings
- integration of technical building equipment in buildings and load bearing structures

The course ‘Planning and Development of Construction (RNB)’ deepens the theoretical aspects of the course 'Principles in Building Construction' through application, development and evaluation. The seminary character and the case studies parallel to the other course, provide the opportunity for discussion, comprehension and application of the following content:
- interdependencies of the safety principles of building construction
- basics of joining and design of detailed solutions
- extended criteria for the choice of building materials, building components and construction types
- interaction between people and buildings
- interaction and responsibility between environment and buildings
- integration of technical building equipment in buildings and load bearing structures

Intended Learning Outcomes:
After participating in the supplementary module 'Advanced Building Construction RNB', students will be able to characterize, implement and apply the basic functional principles of development and design of building construction and construction details. They will be able to detect and to apply the criteria for a sustainable and functional decision-making process for an optimal choice of building materials, components and elements as well as depict the interdependencies between the building and user. Fixed working periods support the students’ time management skills and enable an examination of the comprehension and learning process not just the level of knowledge at a certain time.

Teaching and Learning Methods:
The module consists of two courses which are divided into lectures and practice sessions with blackboard and presentations. Demonstration materials are intended for a better illustration of the topics. The theoretical content will be enlarged upon the application aspects during the seminary. The students will work individually and in small groups on different case studies and tasks. One or more short excursions are planned. Transcripts and summarized learning portfolios assist in the working process.

Explicit case studies supplement the development, transfer and evaluation of abstract functional principles into potential principles for solutions resulting in functional design solutions and options. Due to the continuous supervision during the course, the students will be able to learn different

iteration and optimization processes. The distinction between individual working phases and group work supports the individual learning process as well as teamwork processes.

Media:
Presentations, blackboard presentations, script (lecture-slides) transcript

Reading List:
Script and literature from the mandatory pre-requisite modules, personal transcript will be necessary
- Informationsportal Nachhaltiges Bauen: www.nachhaltigesbauen.de
- Moro et al. (2009), Baukonstruktion – vom Prinzip zum Detail, Band 1-3
- El Khouli, John et al (2015), Sustainable Construction Techniques
- VDI-Richtlinien 2221, 2222, 2223
- Kaufmann et al (2017), Atlas mehrgeschossiger Holzbau
- Binder et al. (2015), Atlas Gebäudeöffnungen
- Bollinger, K. (2012), Atlas moderner Stahlbau
- Peck, M. (2013), Atlas moderner Betonbau
- Kind-Barkauskas, F. (2009) Beton Atlas
- Sedlbauer, K. (2010), Flachdachatlas
- Lienhard, J (2010) Atlas Kunststoffe und Membranen
- Hegger, M. (2012), Energie Atlas

Responsible for Module:
Stefan Winter (bauko@bv.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Konstruktives Planen und Entwickeln (RNB) (Seminar, 2 SWS)
Winter S [L], Hartmann M, Varga Z

Konstruktive Prinzipien des Bauens (Vorlesung mit integrierten Übungen, 2 SWS)
Winter S [L], Winter S, Krechel M, Hartmann M
For further information in this module, please click campus.tum.de or here.

Module Description

EI7513: Ecomanagement and Life Cycle Analysis | Umweltmanagement - Ökoauditierung

Version of module description: Gültig ab summerterm 2017

Module Level: Master	**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:
Die Modulprüfung besteht aus einer Klausur (60 min), die überprüfen soll, inwieweit die Studierenden ein Grundverständnis über Werkzeuge zum Klima- und Umweltschutz ohne Hilfsmittel abrufen können. Dazu werden verschiedene Arten von Fragen (Mehrfachantworten, offene Fragen und Rechenaufgaben) zu den in der Vorlesung behandelten Inhalten gestellt. Die Klausur wird benotet.

Repeat Examination:

(Recommended) Prerequisites:
Folgende Module sollten vor der Teilnahme bereits erfolgreich absolviert sein:
Vorlesung Energiesysteme

Content:
Die Vorlesung bietet eine Einführung in den Werkzeugkasten für eine nachhaltige Entwicklung von Unternehmen sowie übergeordnete Instrumente zum Umwelt- und Klimaschutz.
Es werden die Grundlagen zur Bilanzierung des kumulierten Energieaufwands (KEA) sowie zur Durchführung von Ökobilanzen erarbeitet. Ausgehend von den Ressourcen in der Lagerstätte werden Energieträger, Baustoffe, Metalle, Kunststoffe und andere Produkte auf Halbzeug- und Produktebene bilanziert. Für einzelne Produkte wird der ganze Lebenszyklus von der Herstellung über die Nutzungsphase bis hin zur Entsorgung bewertet. Schwerpunkt wird auf die Ökologie der Stoffströme unter Berücksichtigung von ausgewählten Prozessschritten in der Produktion gelegt.
Auf Grundlage der Ökoauditverordnung werden die einzelnen Aufgaben im Umweltmanagementsystem und in der Umweltbetriebsprüfung in Unternehmen erläutert.
Basierend darauf werden Kommunikationsformen wie beispielweise Umweltberichte und Öko-

Labels vorgestellt und die Herausforderungen in Bezug auf die gesellschaftliche Akzeptanz diskutiert.
Abgeschlossen wird die Vorlesung mit einem Überblick über aktuelle klimapolitische Entwicklungen. Hierbei werden das Kyoto-Protokoll und das Übereinkommen von Paris (COP 21) vorgestellt und die Mechanismen des Emissionshandels (EU ETS) erläutert.

Intended Learning Outcomes:
Der Studierende ist nach dem erfolgreichen Abschluss des Moduls zu Folgendem in der Lage:
- zu erkennen wie die Einbettung technischer Systeme in der Gesellschaft funktioniert,
- die Grundlagen des Öko-Audits zu verstehen,
- aktuelle klimapolitische Instrumente anwenden zu können,
- einfach Ökobilanzen zu erstellen und zu analysieren
- und den kumulierten Energieaufwand (KEA) und Ökobilanzen zu interpretieren und zu bewerten.

Teaching and Learning Methods:
- Vortrag und Diskussion mit Präsentationen und Tafelarbeit
- Ergänzung durch Übungsaufgaben. Es werden z.B. Übungen zur Ökobilanzierung aufgestellt, CO_2 Emissionen berechnet, ebenso der kumulierte Energieaufwand verschiedener Produkte ermittelt.
- In einer abschließenden Exkursion wird die Theorie in der Praxis überprüft. Beispiele aus der Vorlesung werden hier aufgezeigt.

Media:
Folgende Medienformen finden Verwendung:
- Rechnergestützte Präsentation für den Vortrag
- Vorlesungsskript
- Tafelarbeit

Reading List:
Folgende Literatur wird empfohlen:

Kumulierter Energieaufwand für Güter und Dienstleistungen - Basis für Ökobilanzen, IfE Schriftenreihe Heft 26

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

Courses (Type of course, Weekly hours per semester), Instructor:
Umweltmanagement - Ökoauditierung (Vorlesung, 2 SWS)
Neitz-Regett A (Winkelmayer M)
For further information in this module, please click campus.tum.de or here.

Required Electives Modules | Wahlpflichtmodule

Module Description

BGU62043: Aspects of Sustainable Urbanism | Aspects of Sustainable Urbanism

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
written/drawn, cumulative exercises: The Module consists of two parts (A+B) and will be credited with 6 ECTS when both parts are passed successfully.
Part A (40%, individual work): Lecture series and accompanying workshop. Completion of one assignment, that will be developed (from various disciplinary perspectives of sustainable urban design) during workshop sessions and presented in the final session. The assignment will require students to investigate and discuss the presented topics within the particular context of a city. Attendance at the lecture and workshop sessions is mandatory.
Part B (60%, group work): Individual reflection of lecture content, workshop results and reading in a short text and graphic summary as a poster and presentation.
Part A and B are Uploads on Moodle.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
No previous knowledge in the field is required.

Content:
The module provides systemic insight into basic principles of Urban Planning and Design, Urban (Re-)Development, based on key principles Sustainable Urbanism. Focal aspects are (amongst others): – the perception and exploration of key challenges of transformation, techniques of problem identification and conceptualization of resolution strategies in the urban realm, – application of exemplary morphologic and physiologic indicators of urban structure, as well as – the illustration of urban regenerations processes in best practise urban projects. The module

confronts the student with a repertoire of possibilities to integrate complex spatial, aesthetic, social, cultural, ecological and sustainable qualities into contemporary living environments. Physical encounters with the city (on-site workshops) are featured for studying important urban settings and city phenomena in real life.

Intended Learning Outcomes:
After attending the lecture and completing the exercises, the students are able to recognize and understand current patterns of transformation of contemporary urban and suburban structures including connections between ecological, societal and economic factors. Based on the presentation of examples, students can reflect and understand basic ideas and approaches towards more sustainable living environments. Workshop sessions provide insight into the application of basic instruments of urban design and sustainble urban development and enable students to make connections with the focus of their major field of study and its toolsets.

Teaching and Learning Methods:
Lecture series that feeds into a practice seminar: Basic urban design topics are introduced by lecture to then be individually applied in the workshop researching actual plots.

Media:
keynote, exercise sheets, sketching paper

Reading List:
Jane Jacobs. The death and life of great American cities. 1961.
Jan Gehl. Cities for people. 2010.
David Grahame Shayne. Recombinant Urbanism. 2005.

Responsible for Module:
Werner Lang sekretariat.enpb.bgu@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Sociocultural Perspectives of Sustainable Cities (Aspects of Sustainable Urbanism) (Vorlesung, 2 SWS)
Lang W [L], Schade C, Schwering K
For further information in this module, please click campus.tum.de or here.

Module Description

BGU62050: Physical principles of building energy-efficiently | Physikalische Prinzipien des energieeffizienten Bauens

Version of module description: Gültig ab winterterm 2020/21

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

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

Description of Examination Method:
Written Examination (Exam)
Exam duration 90 min

The written examination reviews to which extent the students are able to apply the acquired theories, concepts and mechanisms, with special regard to the respective units, on given problems within a limitied time. The students show by the transfer of the acquired knowledge and strategies to real life problems, to which extent they are able to derive concepts for the energy efficient design of buildings from the manipulation of physical phenomena involved.
The exam is divided into a general part, in which no aids are allowed, and a calculation part, in which a formulary is provided.
Important: The exam will take place online via Moodle. The exam is not proctored, all aids are allowed.

Study Topic (seminar paper)
On the basis of a scientific elaboration (consisting of a seminar paper (approx. 10 pages) and a presentation) of a topic of specialisation, it is examined to what extent physical principles can be summarised, analysed, interpreted and applied to a concrete topic in the field of energy-efficient construction. The topics will be assigned at the beginning of the semester. Possible topics are, for example, the functioning of heat pumps, energy storage using power to gas, the Carnot process, etc.
The scientific elaboration is offered as a mid-term service and, if the exam is passed, makes up 33% of the overall grade. The seminar paper has to be uploaded on Moodle.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Introduction:
system concept, system boundary, system analysis, energy and power balances, conservative and non-coservative forces, system efficiency
Heat:
thermal equilibrium, zeroth law of thermodynamics, change of aggregate state, heat transfer phenomena (dependencies & characteristics, transfer mechanisms, phase diagram, heat capacity, latent & sensible heat, phase change materials
Radiation:
interaction of radiation&matter, transmission, reflection, emission, re-emission, Kirchhoff's law of radiation, Wien's displacement law, solar spectre, low e coating mechanisms
Fluids:
thermal expansion, density anomalies, ideal gas law, Pascal's principle, equation of continuity, equation of Bernoulli
Electricity:
charge, Coulomb's law, electric field, potential differences, sources of voltage and current, current, current density, Ohm's law, dielectrics, capacities

Intended Learning Outcomes:
After participating successfully in the module the students are able to
- determine suitable system boundaries via the analysis of given existing technical or physical systems.
- characterize physical or energy transport mechanisms on the basis of said system boundaries as well as draw energy balances
-apply the concepts of conservative and non-conservative forces on said systems to determine the system efficiency
- distinguish between the mechanisms of heat transfer within and between systems as well as explain the underlying physical effects
- distinguish the heat transport phenomena of latent and sensible heat as well as the associated phase changes
- transfer the temperature-dependent characteristics of electro-magnetic radiation in the thermal and visible range to problems of the built environment
- understand the description of fluid continua
- explain the fundamental behavior of fluid and gaseous media and calculate their state variables at given boundary conditions
- explain the concept of the electric field and distinguish between the resulting effects such as potential difference and current
- derive concepts for the energy efficient design of buildings from the manipulation of the physical effects involved

Teaching and Learning Methods:
Seminar & practical course
In the semiar the teaching contents are conveyed via lectures, presentation and blackboard sketches. Real life examples are demonstrated and discussed in the group. Lecture slides and practice sheets are made available to the studens for self directed learning. In the practical course the problems of practice sheets are presented and the solutions discussed in the group. All module material is provided online.

Media:
Presentation, black/whiteboard, practice sheets

Reading List:
Urone, P.P.; Hinrichs, R. et al.: College Physics, 978-1-938168-00-0, OpenStax, 2012
Tipler, P.A.; Mosca, G.: Physik für Wissenschaftler und Ingenieure, 978-3-8274-1945-3, Spektrum, 2009
Meschede, D.; Gerthsen, C.: Gerthsen Physik, 978-3-642-12893-6, Springer, 2010

Responsible for Module:
Werner Lang sekretariat.enpb.bgu@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Physikalische Prinzipien des energieeffizienten Bauens (Seminar, 4 SWS)
Lang W [L], Meier-Dotzler C, Schwering K
For further information in this module, please click campus.tum.de or here.

Module Description

BGU62047: Interdisciplinary Project - Resource-Efficient and Sustainable Building 1.0 | Interdisziplinäres Projekt - Ressourceneffizientes und nachhaltiges Bauen 1.0 [IDP RNB 1.0]

Version of module description: Gültig ab summerterm 2019

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** summer semester
Credits:* 12	**Total Hours:** 360	**Self-study Hours:** 225	**Contact Hours:** 135

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

Description of Examination Method:
Students give proof of their achievement by working on a sustainable design project that involves new or existing buildings in the setting of sustainable district development. The project work takes place in the form of group work. The assessment of the project is based on a written project paper and a presentation of the results at the end of the semester.
The aim of the interdisciplinary project work is to provide proof that the students are able to:
- develop a concrete sustainable building design concept based on the criteria, indicator systems and planning instruments of sustainable and energy-efficient planning, taking account of the aesthetic, social, legal, economic, ecological, functional, technical, structural and climatic requirements, and to develop project-specific solutions for implementation in teamwork
- take account of the current state of the political and scientific debate in the joint project work (in the phases of problem definition, brainstorming, criteria development).

The aim of the final presentation is for the students to demonstrate their ability to give a vivid and concise account of the scientific development process leading to their design/building concept and of their essential findings.

Repeat Examination:

(Recommended) Prerequisites:

Content:
The focus of the Interdisciplinary Project is on exploring current issues of sustainable building. The project's system boundary is defined by the district in which it is set. In most cases, this is an existing district where concrete action is needed to improve the current situation.

Topics covered by the project include:
- climate-neutral buildings
- energy-efficient and sustainable building
- use and reuse of renewable raw materials in construction
- energy supply-based renewable energy sources
- high-quality interior development in compliance with building regulations
- mixed uses
- sustainable mobility
- free space and ecosystem services
- sustainable lifestyles
- citizen participation concepts
- affordable housing.

These topics are integrated into the whole district through an overarching general concept (vision) and urban design concept. At the building level, specific measures are being developed with regard to architectural design, building physics and energy technology. Their implementability is demonstrated through simulations and calculations, e.g. energy demand calculations, life-cycle assessments and costs of construction.

Intended Learning Outcomes:
After participating in the Interdisciplinary Project, students are able to
- develop integrated sustainable building design concepts taking account of the aesthetic, social, legal, economic, ecological, functional, technical, structural and climatic requirements
- use the criteria, indicator systems and planning tools of sustainable building, as well as the assessment tools for integrated building assessment, applying them to a specific design/planning concept
- analyse both the ecological and the often decisive economic necessity of a full life cycle assessment from raw material extraction to disassembly, and to make an assessment based on concrete examples
- understand the current state of the political and scientific sustainability debate
- engage in teamwork on a specific project assignment for the development of a sustainable building concept in the various project phases (including initiation, problem definition, assignment of roles, development of criteria, decisions, implementation, presentation, written assessment), working in a solution-oriented way
- assess the relevant aspects in a specific local, regional or national context and develop feasible results
- demonstrate their ability to give a vivid and concise account of the scientific development process leading to their design/building concept and of their essential findings in a final presentation.

Teaching and Learning Methods:
In the Interdisciplinary Project, interdisciplinary teams (with a group size of approx. 4-7 students) work together to explore a current issue related to sustainable building. This includes the design and development of a project that involves new or existing buildings in the setting of sustainable district development. The aim is the unassisted development of project-specific solutions to implement sustainable design concepts based on sustainable and energy-efficient planning, taking account of topics such as infrastructure, urban space, energy and material-related issues. This leads to enhanced interfacing between the strategies and approaches of various disciplines such as architecture, civil engineering and environmental engineering with the aim of developing a joint synthesis. The understanding and the interdisciplinary discussion provide the basis for sustainable design while working on the project. An essential part of the interdisciplinary work is communicating across different specializations and boundaries with the aim of finding a common language of communication and understanding.

The topic is presented during a first session at the beginning of the semester. In the first project phase, the students document their plans for the overall project process and their approach to the project work in the form of a written exposé. This exposé contains the following elements: introduction, vision, background and problem statement (SWOT analysis), objectives of the project work, method(s) used for this purpose, draft structure of the paper, description of project management, timeline. The exposé will be discussed with the lecturers and adapted as far as necessary. The lecturers from the included disciplines hold project mentoring sessions with the students throughout the semester. The students present the preliminary results of the subprojects in interim audits taking place during the semester, discuss them together with the lecturers and assess them against the results to be achieved. At the end of the semester, on conclusion of the project, all results are presented in a final audit, which may take place in the presence of guest critics. The expertise of the teaching staff from the leading faculties of the five participating disciplines is contributed in the discussion on the respective project topic, enhancing the degree of networking between the different disciplines.

Media:
Projector presentations, presentations of plans, discussions, software tools, plans and model

Reading List:
Bott, H., Grassl, G. C., & Anders, S. (2014). Nachhaltige Stadtplanung: Konzepte für nachhaltige Quartiere. [München]: Detail.
Ekardt, F. (2016). Theorie der Nachhaltigkeit: Ethische, rechtliche, politische und transformative Zugänge - am Beispiel von Klimawandel, Ressourcenknappheit und Welthandel (2., vollständig überarbeitete und aktualisierte Auflage). Baden-Baden: Nomos.
Friedman, T. L. (2009). Hot, flat, and crowded: Why we need a green revolution--and how it can renew America (Release 2.0, updated and expanded ; 1st Picador ed.). New York: Picador/Farrar, Straus and Giroux.
Heck, H.-D., & Meadows, D. L. (1972). Dennis Meadows [u.a.] Die Grenzen des Wachstums (The limits to growth, dt.).

McDonough, W., & Braungart, M. (2002). Cradle to cradle: Remaking the way we make things (First edition). New York: North Point Press.
Meadows, D. H., Meadows, D. L., & Randers, J. (1992). [Hauptband] (6. Aufl.). Die neuen Grenzen des Wachstums : die Lage der Menschheit: Bedrohung und Zukunftschancen / Donella H. Meadows: A. Stuttgart: Dt. Verl.-Anst.

Responsible for Module:
Werner Lang sekretariat.enpb.bgu@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Interdisziplinäres Projekt Ressourceneffizientes und nachhaltiges Bauen 1.0 (Projekt, 9 SWS)
Lang W [L], Göttig R, Hepf C, Lang W, Schade C, Schwering K, Staudt J, Werther N
For further information in this module, please click campus.tum.de or here.

Module Description

BGU62048: Application of an Life Cycle Assessment | Anwendung einer Lebenszyklusanalyse

Version of module description: Gültig ab summerterm 2021

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 besteht aus einer wissenschaftlichen Ausarbeitung inklusive einer kurzen Präsentation.
In der wiss. Ausarbeitung, (Umfang 30-40 Seiten) zeigen die Studierenden, ob sie in der Lage sind, eine konkrete Anwendung einer Lebenszyklusanalyse (LCA) auf ein bestehendes oder geplantes Gebäude wissenschaftlich korrekt wiedergeben zu können. Die Ausarbeitung zielt darauf ab zu prüfen, inwieferne eine wiss. Auseinandersetzung mit der Aufgabenstelltung unter den Gesichtspunkten der Anwendung zielführender wissenschaftlicher Methoden erfolgt. Die dabei geforderte konkrete Anwendung einer Lebenszyklusanalyse (LCA) auf ein Gebäude basiert auf dem Beispielprojekt des Interdisziplinären Projekts.
In einer kurzen Präsentationen (ca. 10 Min.) zeigen die Studierenden, dass sie in der Lage sind, die Sachverhalte rethorisch wiedergeben zu können, und sich in einem Dialog mit dem Publikum über das Thema auseinander zu setzen.
Die Prüfungsleistung erfolgt Online: die wissenschaftliche Ausarbeitung wird über Moodle hoch geladen und die Präsentationen finden über ZOOM statt.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Die erfolgreiche Teilneahme an dem Modul Ökobilanzierung BV360009

Content:
Der Inhalt zum Modul Anwendung einer Lebenszyklusanalyse (LCA) besteht aus:

• Vermittlung der Grundlagen einer Gebäude LCA
• Vermittlung von Softwarekentnissen zur Durchführung einer LCA

• Berechnung und Auswertung von Energie und CO2 Bilanzen auf Material und Bauteilebene
• Ermittlung von Potentialen zur Reduzierung der Umweltauswirkungen
• Studierende bearbeiten eigenständig ein gegebenes Projekt
• Vorstellung der erarbeiteten Ergebnisse im Rahmen eines Vortrags und Ausarbeitung einer Seminararbeit

Intended Learning Outcomes:
Die Studierenden sind nach der Teilnahme am Modul in der Lage:
- Fundiertes Grundlagenverständnis über die Ökobilanzierung wiederzugeben
- Ökobilanz-Ergebnisse adäquat zu bewerten.
- Energie- und CO2-Bilanzen zu analysieren.
- Die wichtigsten ökologischen Stellschrauben an einem Gebäude zu verstehen zu bewerten.
- Berechnungen in einer Ökobilanz-Software (eLCA) auf konkrete Gebäude anzuwenden.
- bestehende Gebäudestrukturen hinsichtlich der verwendeten Bauteile und Materialien über alle Lebenszyklusphasen zu analysieren und Optimierungsvorschläge zu erarbeiten
- Empfehlungen für ökologische Optimierungen eines Gebäudeentwurfs unter Berücksichtigung aller Lebenszyklusphasen zu entwickeln.
- eine Lebenszyklusanalyse auf ein Gebäude wissenschaftlich korrekt wiederzugeben.

Teaching and Learning Methods:
Das Modul besteht aus einem Seminar. In dem Seminar finden vereinzelt Input Vorträge statt, um den Studierenden notwendige Grundlagen über die Ökobilanz und einer Lebenszyklusbetrachtung zu vermitteln. Basierend auf den Vorträgen findet im Seminar die Anwendung dieses Wissens an einem konkreten interdisziplinären Beispielprojekt statt. Die Studierenden bearbeiten die Aufgabenstellung in Gruppenarbeit und werden durch den Lehrenden betreut (Gruppenarbeit, Seminar). Mit Hilfe der Gruppenarbeit wird eine interdisziplinäre Arbeitsweise als auch Auseinandersetzung mit der gestellten Aufgabe ermöglicht. Hierbei wird eine fürs Berufsleben zeilführende Arbeitsweise gelehrt und gefordert. Die Teilnehmer entwickeln anhand eines konkreten Projekts in Gruppenarbeit nachhaltige Bauteile und identifizieren die damit einhergehenden Auswirkungen auf das Gebäude und die Umwelt.Der Schwerpunkt liegt auf der Anwendung einer Lebenszyklusbetrachtung am konkreten Gebäude und dem Verständnis der wichtigsten Stellschrauben. Dabei ist es besonders wichtig, ökologische Fragestellungen in frühen Planungsphasen projektspezifisch zu erarbeiten und zu beantworten.

Media:
Power Point, eLCA

Reading List:
DIN, ENISO. 14044: 2006-10 Umweltmanagement–Ökobilanz–Anforderungen und Anleitungen. DIN Deutsches Institut für Normung eV Berlin: Beuth Verlag, 2006. DIN, ENISO. 14040: Umweltmanagement–Ökobilanz–Prinzipien und allgemeine Anforderungen. Deutsche Fassung der EN ISO, 1997, 14040. Jg., Nr. 1997, S. 16. KÖNIG, Holger, et al. Lebenszyklusanalyse in der Gebäudeplanung. Institut für internationale Architektur-Dokumentation, München, 2009.

Responsible for Module:
Werner Lang sekretariat.enpb.bgu@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Anwendung einer Lebenszyklusanalyse, nur für RNB Studierende, die am IDP teilnehmen (Seminar, 4 SWS)
Lang W [L], Schwering K, Takser I
For further information in this module, please click campus.tum.de or here.

Module Description

BGU62049: Social Skills and Interdisciplinarity | Kommunikation und Interaktion

Version of module description: Gültig ab summerterm 2019

Module Level: Master	**Language:** German/English	**Duration:** two semesters	**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 takes place in the form of a presentation. Its objective is to prove that students have understood the imparted working and communication techniques and are able to apply them in a presentation. By interacting with the examiners and the audience, students have to demonstrate and reflect on aspects of essential techniques, analysing typical problems in a goal-oriented way, finding possible solutions and assessing their feasibility. The fact that the exam takes place in verbal form enables an iterative technique, asking questions with increasing complexity and assessing the students individually, enabling a realistic evaluation of the skills acquired in the module. The aim of the presentation is for students to demonstrate their ability to give a vivid account of specific facts and to respond to questions, suggestions or discussions related to the topic addressed.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
keine

Content:
The module covers the following elements:
- presentation techniques (theoretical study and practical exercises)
- communication techniques (verbal, non-verbal and visual), such as discussion training (theoretical study and practical exercises)
- interdisciplinary work (theoretical study and practical exercises based on the Interdisciplinary Project)
- social skills, such as self-esteem, self-confidence, self-efficacy, self-observation, presence and charisma, self-responsibility, empathy/adopting different perspectives, ability to make

compromises, the ability to take criticism, language skills, intercultural competence (theoretical study and practical exercises)
- Expertise/professional competence, such as teamwork, cooperation, motivation, ability to address conflicts, business etiquette and communication skills (theoretical study and practical exercises)
- foundations of scientific writing, such as structure, breakdown, developing lines of argumentation, sentence structure and choice of words (theoretical study)

The elements covered are applied in practice mainly in the Interdisciplinary Project.

Intended Learning Outcomes:
This module aims to support students in studying, understanding and applying the areas mentioned above on an individual basis. After attending the course, students are able to develop strategies, aids, methods and application examples with experts. The aim is to create a group identity and to encourage beneficial teamwork while promoting personal development. In addition, the following skills are acquired or improved: rhetoric, demeanour, presentation style, time management, abstraction ability, conscientiousness and teamwork.
After attending the module, the students are also able to
- structure and take on responsibility for coordination tasks in interdisciplinary teams in addition to addressing specific subjects
- identify potential tensions and dynamic forces through teamwork, and to deal with them in a constructive and considerate way
- apply essential aspects of scientific writing
- work on a topic of research in an independent, solution-oriented and structured way

Teaching and Learning Methods:
Lectures, presentations given by students, role plays, research, exercises (e.g. in form of presentation, demeanour, oral and written communication, rhetoric and self-perception) and video analysis. These methods enable students to apply the acquired techniques during the seminar and to further improve their skills.
The communicative and interactive skills are conveyed through lectures, exercises and workshops. Depending on the individual focus, the social skills and the communication skills between the students are enhanced.
In addition, students have to work on various assignments during the seminar in which they can apply the essential techniques. Possible assignments include: short lectures, role plays, workshops or exercises. Students work on them on their own, both during and outside of the contact phase.

Media:
PowerPoint, script, films, worksheets

Reading List:
Allhoff, Dieter-W.; Allhoff, Waltraud (2014): Rhetorik und Kommunikation. reinhardt Verlag
Eller, Frank; Noelle, Oliver (2008): Die 7 Schritte zu einer erfolgreichen Präsentation. books on demand, Norderstedt
Hinsch, Rüdiger; Wittmann, Simone (2010): Soziale Kompetenzen kann man lernen. Beltz Verlag

Kanning, Uwe Peter (2007), Förderung soziale Kompetenzen in der Personalentwicklung, Hogrefe
Schulz von Thun, Friedemann (1998): Miteinander reden 1. Störungen und Klärungen. Rowolth Taschenbuch Verlag.
Watzlawick, Paul; Beavin, Janet H.; Jackson, Don D. (1996): Menschliche Kommunikation. Formen, Störungen, Paradoxien. Verlag Hans Huber.

Responsible for Module:
Werner Lang sekretariat.enpb.bgu@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Kommunikation und Interaktion (Seminar, 2 SWS)
Lang W [L], Forster P, Kierdorf D, Lang W, Schwering K

Kommunikation und Interaktion (Seminar, 2 SWS)
Lang W [L], Forster P, Kierdorf D, Lang W, Schwering K
For further information in this module, please click campus.tum.de or here.

Master's Thesis mit Masterkolloquium | Master's Thesis mit Masterkolloquium

Module Description

BGUMTRNBT2: Master's Thesis with Mastercolloquium | Master´s Thesis mit Masterkolloquium

Version of module description: Gültig ab winterterm 2018/19

Module Level: Master	**Language:** German/English	**Duration:** one semester	**Frequency:** winter/summer semester
Credits:* 30	**Total Hours:** 900	**Self-study Hours:** 900	**Contact Hours:**

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

Description of Examination Method:
The module examination consists of the following parts:
- Scientific write-up of the Master's Thesis: The student proofs ability to individually solve a problem within the field of the Master' Degree by creating individual concepts and conducting hands-on research (80% of module grade).
- Final presentation: With the final presentation the student proofs the ability to present, reflect, and dicuss methods and results in a structured way (pass/fail credit requirement, has to be passed) (20% of module grade).

Repeat Examination:

(Recommended) Prerequisites:
Permit of the board of examiners, proofing a sufficient study progress according to the exam regulations

Content:
Every student self-responsibly works with scientific methods on an individual research topic as agreed with the scientific examiner that deals with a problem within the field of the Master's Degree.

Intended Learning Outcomes:
After successful completion of the module, students are able to define a scientific problem within the field of the Master's Degree or categorize a problem within existing theories. They are able to identify, discuss, and apply suitable methods to the problem out of the methods learned during studies as well as relevant literature. The abilities include discussion and presentation of results with both supervisor and interested audience, drawing conclusions, and setting and following a timeline or project plan within the given deadlines.

Teaching and Learning Methods:
During the participation in the module the students practice engineering. The Master's Thesis has the format of a scientific work that not only contains scientific tasks, but might also incliude planning and conceptual elements that are part of the work scope in professional engineering life.
Every participant works on an individual technical task, especially in independent way.
Every participant is supported by a scientific advisor.

Media:
Self-study / practical work under the guidance of a scientific examiner

Reading List:
suitable Literature for choosen Topics

Responsible for Module:
Studiendekan

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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