Technische Universität München

Module Catalog

B.Sc. Environmental Engineering

Civil, Geo and Environmental Engineering

Technische Universität München

www.tum.de
www.bgu.tum.de

Module Catalog: General Information and Notes to the Reader

What is the module catalog?

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

Notes to the reader:

Updated Information

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

Non-binding Information

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

Elective modules

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

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Fundamentals and Orientation Examinations

Technische Universität München

Module Description

MA9501: Advanced Mathematics 1

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The module examination is based on a written exam (120 minutes). Students have to know basic concepts of Linear Algebra and Analytic Geometry, as well as of Mathematical Analysis and are familiar with the calculus in these cases. They show their ability to deal with mathematical problems of structural and surveying engineering in limited time.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
preparatory course mathematics

Content:
Sets, numbers, functions, vector calculus and analytical geometry, matrix algebra, determinants, systems of linear algebraic equations, least squares data fitting, eigenvalues of matrices, differential and integral calculus for scalar functions of a single real variable.

Intended Learning Outcomes:
After successful completion of the modul, students are able to understand and apply basic concepts of Linear Algebra and Analytical Geometry, as well as of Mathematical Analysis.

Teaching and Learning Methods:
lecture, exercise session

Media:
blackboard

Reading List:
Rainer Ansorge and Hans Joachim Oberle, Mathematik für Ingenieure 1, 4. Auflage, Wiley-VHC Verlag 2010.

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

Courses (Type of course, Weekly hours per semester), Instructor:
Mathematics for Engineers 1 (BGU) (Central Exercise Session) (exercise, 2 SWS)

Johann A

Mathematics for Engineers 1 (BGU) (lecture, 4 SWS)
Johann A

Mathematics for Engineers 1 (BGU) (Exercise Session) (exercise, 2 SWS)
Johann A

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

Module Description
BV000001: Technical Mechanics I

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The learning outcome is confirmed by passing a 90 minute examination.
The aim of the written examination is the confirmation that the fundamental mechanical concepts of kinematics, forces and moments including the equilibrium of forces, calculation of work, multiaxial stresses and their resulting forces have been understood and can be concisely repeated and applied. Furthermore, problems must be analyzed and solution approaches found and applied within a limited time using the learning outcomes achieved during the module.

The solutions sometimes require the student`s own interpretation, partly selection of single or multiple choice answers, whereby the emphasis is on short calculation exercises.

No auxillary means are allowed in the exam.

During the semester students can achieve midterm assessments. By means of the midterm performance the final grade of the written exam can be improved by 0,3. In the scope of the lecture a total of 3 peer-worksheets and a mock exam are provided, in order to apply the essential concepts for the calculation of stresses and displacements of bar-shaped elements (Bending beam theory, St. Venantsche Torsion theory, definition and principle of work) to practical examples. This imparts the competencies on applying and evaluating the methods and findings of mechanics. For the midterm to be passed and introduced into the final grade, students have to pass a minimum of 75% of the midterm assessments. A midterm assessment is deemed to be passed if a minimum of 50% of the score has been reached and a reasonable peer-review of three further submission has been approved. The bonus will only be granted in the same term as the midterm performance has been achieved. A degradation of the grade is not foreseen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The knowledge taught at German grammar schools in the field of differential and integral calculus and the fundamentals of linear algebra are assumed.

Content:
The module lays important fundamentals for the following constructive engineering subjects.

The thematic outline is as follows:

- Degrees of freedom of two and three dimensional systems, kinematic dependencies
- Spatial, plane, linear and discrete forces and their resulting forces

- Single forces and moments
- Geometrical moment of inertia
- Center of gravity
- Definition of the equilibrium of forces
- Principle of virtual work
- Cutting principle
- Calculation of work
- Supporting forces and internal forces of statically determined systems with use of equilibrium of forces and the principal of virtual work (framework, beam, arch girder)
- Adhesion and friction
- Stability of rigid systems
- Theory of second order
- Multiaxial stress states (Mohrs circle of stress, stresses in rotated systems, principal stresses)
- Hypothesis of material failure for multiaxial stress states

Intended Learning Outcomes:
After successfully completing the module, students can apply the concepts of forces and moments, degrees of freedom, bindings and supports. They can distinguish the fundamental mechanical principles of work and solve problems by determining the classical equilibrium of forces. The participants are able to determine supporting and internal forces of statically determined systems with the use of equilibrium of forces, virtual work or differential equations. The students are able to classify simple stability problems for rigid structures. They can apply the theory of multiaxial stress states (stresses on various sections, rotation of coordination system) on simple tasks.

Teaching and Learning Methods:
The module consists of lectures and exercises. The topics of the lecture are taught with the help of presentations, animations, real and abstract models as well as via discussions with the students. Further the lecture should encourage the students to enrich their studies through additional literature. In the scope of the exercises selected examples and computational problems are discussed. In addition exercise sheets and E-tests are provided with which the material can be fully internalized and practiced. The voluntary exercise sheets should be worked on alone and then are fully solved in the seminars. The voluntary E-test solutions are available immediately after completion. Furthermore, short tasks are digitally submitted to the students and they are encouraged to answer them before the lecture using their smartphone. The answers to those tasks are discussed at the beginning of the lecture. Additional sessions will be offered for the exam preparation.

Media:
- Lecture notes with additions during the lectures (Tablet-PC with projector)
- Notes based on the blackboard notes during the exercises
- small models, springs, cable, rubber foam systems
- Films and animations
- Examples with Computer Algebra Systems
- Use of Audience Response Systems during the lecture
- Representative examination questions along with their solutions will be made available online
- Exercise sheets with (time delayed) solutions will be made available online

Reading List:
Gross, D., Hauger W., Schröder J., Wall W. A.: Technische Mechanik, Band 1 und Band 2, Springer Verlag

Responsible for Module:
Prof. Dr.-Ing. Gerhard Müller

Courses (Type of course, Weekly hours per semester), Instructor:
Seminar Technical Mechanics I (seminar, 1 SWS)
Englert H, Schmaußer C, Aumann Q

Technical Mechanics I (lecture with integrated exercises, 6 SWS)
Müller G, Englert H, Aumann Q, Schmaußer C

Tutorial Technical Mechanics I (seminar, 2 SWS)
Müller G, Englert H, Schmaußer C, Aumann Q

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

Module Description

BGU65010T2: Computation in Civil and Environmental Engineering 1

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The examination consists of two parts, a written 60 minute examination and a non-graded assessment consisting of four exercises.

The exercises are practical problems which have to be solved on the computer. These assess the acquired skills of a thematically closed topic of a computer-aided engineering example from practice. This proofs understanding and the specific capabilities utilising basic instruments of computer-aided engineering practice: the topics are CAD (Computer Aided Design), engineering applications of spreadsheets, engineering-specific databases and software development with MATLAB. They are prepared independently and audited in individual interviews. They serve the purpose of students reflecting on the individual subjects and are capable of reproducing their main points.

In the exam, students need to prove they understand the acquired theoretical concepts and methods of computer aided engineering and are capable to use them for the structured analysis and reflection of engineering problems using knowledge and comprehension questions. These topics involve elementary geometric models, information models for buildings and infrastructure, basics of software development and structured programming as well as elementary program structures, data types and functions. In the written examination no aids are permitted.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic competence with computers, office-applications, internet

Content:
Computer Aided Design / BIM
- basic geometric models: wireframe-, surface-, volume models
- CAD: computer aided design
- information models for buildings and infrastructure

Spread sheets
- application of spread sheets in engineering

Databases
- Database theory and application
- Introduction to SQL

Software Development
- basics of software development
- structured programming
- software development using MatLAB
- basic programming structures, data types, functions

Intended Learning Outcomes:
After completing the module students will be able to:
- utilize the basics of computational engineering
- generate 2D- and 3D- Models using a CAD-System
- read and create technical drawings conforming to standards
- asses pros and cons of computer based descriptions of geometric models
- apply spread sheet programs to engineering problems
- choose from basic solution algorithms
- reproduce basics of databases and create queries to common database systems
- understand elementary basics and theoretical concepts of computer aided engineering
- choose from basic solution algorithms
- formulate those algorithms in a programming language (e.g. MATLAB) and combine them with suitable software

Teaching and Learning Methods:
Teaching and learning methods:
The teaching results of the module are achieved by multiple coordinated components. The lectures are supported by
PowerPoint presentations, blackboard scripts and movies illustrating computer simulations. The lecture content is completed by exercises in the lecture hall. Here, the methods required for completing the assignments are demonstrated live using a computer. Exercise sheets which need to be completed successfully will be distributed and
are part of a non-graded student assignment. Students work on the assignments in practical sessions where they are
supported by student tutors. Basic knowledge of engineering informatics has to be achieved during private study. Once a semester, an a guest lecture will be held by a local industry partner in order to deliver insight into the broad spectrum of computational civil engineering.

Media:
Lecture notes, PowerPoint presentations, and blackboard usage. Live demonstration of computer programs and solution concepts.

Reading List:
- Rank, E.; Borrmann, A. and scientific staff: "Bau- und Umweltinformatik I" (german)
- lecture notes and PowerPoint slides

Responsible for Module:

Courses (Type of course, Weekly hours per semester), Instructor:
Computation in Civil and Environmental Engineering 1 (lecture with integrated exercises, 3 SWS)
Borrmann A, Braun A, Esser S, Markic S

Exercises to Computation in Civil and Environmental Engineering 1 (practical training, 1 SWS)
Braun A, Jahr K, Kopp P, Markic S, Paolini A, Trzeciak M, Vilgertshofer S

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

Technische Universität München

Module Description

CH6202: General an Inorganic Chemistry

Civil, Geo and Environmental Engineering

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

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

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

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Keine

Content:
In diesem Modul werden den Studierenden grundlegende Begriffe der allgemeinen Chemie (Verwendete Einheiten und Stoffgrößen der Chemie) erklärt. Mit diesen erlernen die Studierenden nach welchen Prinzipien und Methoden chemische Reaktionen, Rechnungen und Fragestellungen zu bearbeiten sind, es handelt sich beispielsweise um das Aufstellen von Reaktionsgleichungen, die Berechnungen von pH-Werten, von Einwaagen, von Konzentrationen sowie die Erarbeitung der Grundlagen der Elektrochemie, ect. Neben den allgemeinen Aspekten der Chemie steht weiterhin die anorganische Stoffchemie im Vordergrund dieser Vorlesung. Hierbei wird überwiegend auf die Hauptgruppenelemente eingegangen. Den Studierenden wird dort stoffspezifisch das unterschiedliche Verhalten der Elemente erklärt (Reaktivität von Elementen und Verbindungen). Es werden von jedem Element wichtige und anwendungsrelevante Verbindungen besprochen. Hierbei wird auf wichtige Teilaspekte für Umweltingenieure näher eingegangen (z.B.: Toxizität von Verbindungen, Treibhaus- und Umweltproblematik verschiedener Stoffe, Ansätze zur verbesserten Energieeffizienz, etc.).

Intended Learning Outcomes:
Nach der Teilnahme am Modul "Allgemeine und Anorganische Chemie" sind die Studierenden in der Lage die Prinzipien und Methoden der Chemie, welche sich überwiegend in den analytischen Denkweisen und den angewandten Rechnungen wiederspiegeln, zu verstehen und anzuwenden. Weiterhin entwickeln die Studierenden einen analytischen Blick für aktuelle Probleme (z. B. Feinstaubdiskussion).

Teaching and Learning Methods:
Die Veranstaltung besteht aus einer Vorlesung (2 SWS) mit begleitender Übung (1 SWS). Die Inhalte werden in der Vorlesung im Vortrag und durch Präsentationen vermittelt. Studierende sollen zur inhaltlichen Auseinandersetzung mit den Themen und zum Studium weiterführender Literatur angeregt werden. Die

Übungsaufgaben der begleitenden Übungsveranstaltung werden koordiniert zum Vorlesungsfortschritt vorgeführt und durch ausgegebene Hausaufgaben vertieft.

Media:
Vortrag, Präsentationen, Übungsaufgaben, Hausaufgaben

Reading List:
C. E. Mortimer, Chemie, Das Basiswissen der Chemie;
E. Riedel, Allgemeine und Anorganische Chemie

Responsible for Module:
Plank, Johann Peter; Prof. Dr.

Courses (Type of course, Weekly hours per semester), Instructor:
English title will be supplied (exercise, 1 SWS)
Plank J, Stecher J

English title will be supplied (lecture, 2 SWS)
Plank J, Stecher J

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

Technische Universität München

Bachelor Degree

Technische Universität München

Degree Requirements

Technische Universität München

Module Description

BGU51017: Descriptive Geometry [DG]

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The achievement of the study goals is tested in a written exam lasting 60 minutes, including drawing exercises and questions of comprehension. In the drawing exercises the students are to show their ability to solve three dimensional geometric problems through planar representation and to draw technical objects accurately. The comprehension questions will test the students¿ knowledge on the terminology of descriptive geometry and technical drawing. The results of the exercises, lecture notes and a simple calculator are permitted during the exam.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
The course introduces different methods of correctly depicting technical objects and trains the ability for spatial visualization. Possibilities on how objects can be represented in a two dimensional plane and corresponding geometric problems will be discussed. Furthermore, methods of amending and modifying simple projections, e.g. through text, dimensions, scales and line styles, to create technical drawings will be presented. During the course different drawing styles (free hand and guided drawing, computer aided design) will be introduced.

Intended Learning Outcomes:
After completing the course students will be able to depict three dimensional object on planar surfaces by projection, solve geometric problems in space using planar representations and correctly produce and read technical drawings.

Teaching and Learning Methods:
The course utilizes multi-media presentations and models to explain how to illustrate how objects can be represented in a two dimensional plane and how to solve related geometric problems. Each topic progresses from simple to complex. The purpose, possibilities and rules of technical drawing will be explained with the help of slide presentations and multiple examples. The presented subject matter will be revisited in step-by-step drawing exercises together with the lecturer. With this approach, students can continuously follow their own progress. Voluntary home work is offered for further self-study which together with the class room exercises provide optimal preparation for the final written exam.

Media:
Drawings, illustrative models, aid sheets for simultaneous drawing at the lecture, multimedia presentations,

exercise sheets for homework, script

Reading List:
not necessary

Responsible for Module:
Winter, Stefan; Prof. Dr.-Ing.

Courses (Type of course, Weekly hours per semester), Instructor:
Descriptive Geometry (lecture with integrated exercises, 2 SWS)
Winter S [L], Henke K, Talke D

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

Technische Universität München

Module Description

MA9502: Advanced Mathematics 2

Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Bachelor	German	one semester	summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
6	180	90	90

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

Description of Examination Method:
The module examination is based on a written exam (120 minutes). Students have to show their knowledge of Mathematical Analysis and can apply them to advanced problems of structural and surveying engineering in limited time.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
MA9501 - Höhere Mathematik 1

Content:
Advanced differential and integral calculus for scalar functions of a single real variable, Fourier series, differential and integral calculus for functions of several real variables, multiple integrals, line integrals and surface integrals, integral theorems by Green, Gauss and Stokes, implicitly defined functions, nonlinear algebraic equations, nonlinear least square data fitting, extreme value problems and optimization, theory of ordinary differential equations, linear ordinary differential equations, initial value and boundary value problems.

Intended Learning Outcomes:
After successful completion of the modul, students are able to understand and apply advanced concepts of Mathematical Analysis.

Teaching and Learning Methods:
lecture, exercise session

Media:
blackboard

Reading List:
Rainer Ansorge and Hans Joachim Oberle, Mathematik für Ingenieure Band 1 and 2, 4. Auflage, Wiley-VHC Verlag 2010 and 2011.

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

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

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

Technische Universität München

Module Description

BV000004: Technical Mechanics II [TM 2]

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The learning outcome is confirmed by passing a 90 minute written examination at the end of the semester.

The aim of the written examination is the confirmation that, building on the learning outcomes of Technical Mechanics I, the core concepts for the calculation of stresses and displacements of bar-shaped elements (bending theory for beams, St. Venant's Torsion Theory, definition and principle of work) have been understood and can be concisely repeated and applied. Also it should be guaranteed that the fundamental aspects of dynamic processes can be described. Furthermore, problems must be analyzed and solution approaches found and applied within a limited time using the learning outcomes achieved during the module.

The solutions sometimes require the student`s own interpretation, partly the selection of single or multiple choice answers, whereby the emphasis is on short calculation exercises.

No auxillary means are allowed in the exam with the exception of a collection of formulae (provided).

During the semester students can achieve midterm assessments. By means of the midterm performance the final grade of the written exam can be improved by up to 0,3. In the scope of the lecture a total of 14 worksheets and a mock exam are provided, in order to apply the essential concepts for the calculation of stresses and displacements of bar-shaped elements (Bending beam theory, St. Venantsche Torsion theory, definition and principle of work) to practical examples. This imparts the competencies on applying and evaluating the methods and findings of mechanics. For the midterm to be passed and introduced into the final grade, students have to pass a minimum of 80% of the midterm assessments. A midterm assessment is deemed to be passed if a minimum of 50% of the score has been reached and a reasonable peer-review of three further submission has been approved. The bonus will only be granted in the same term as the midterm performance has been achieved. A degradation of the grade is not foreseen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Mechanical and mathematical fundamentals (differential calculus and geometry) are assumed.
Basic modules: Technical mechanics I, Advanced mathematics I

Content:
The focus of the module is on the expansion of the fundamentals taught in Technical Mechanics I to cover elastic systems as well as inhomogeneous sections and non linear material.

The thematic outline is as follows:

- Stress-strain relationships
- Tensile and compressive forces
- Energy theorems
- Beam bending
- Stability of elastic systems
- Composite sections and inhomogeneous sections
- Non-linear material behavior, elasto-plastic behavior
- Shear stresses due to bending
- Torsion
- Introduction into the dynamics of a single-degree-of-freedom system

Intended Learning Outcomes:
After successfully completing the module, students understand the idealizations and models used for the calculation of stresses and displacements of bar shaped elements. The students are able to assess such systems on the basis of the combination of the equlibrium of forces, kinematic and constitutive equations. Moreover students shall be able to apply the bending theory for beams and the St. Venant's Torsion Theory as well as the energy theorems. Students are be able to determine the stress state in a given system. Students can analyze dynamic processes with help of the Single Degree of Freedom System. This module shall impart the competence to identify the limits of the models used in order to assess them before choosing the appropriate method.

Teaching and Learning Methods:
The module consists of lectures and exercises. The topics of the lecture are taught with the help of presentations, animations, real and abstract models as well as via discussions with the students. Further the lecture should encourage the students to enrich their studies through additional literature. In the scope of the exercises selected examples and computational problems are discussed. In addition exercise sheets and E-tests are provided with which the material can be fully internalized and practiced. The students should firstly work on the voluntary exercise sheets on their own before the solution is discussed and explained in seminars. The voluntary E-test solutions are available immediately after completion so that results can be compared. Furthermore, short tasks are digitally submitted to the students and they are encouraged to answer them before the lecture using their smartphone. The answer to those tasks are discussed at the beginning of the lecture. Additional sessions will be offered for the exam preparation.

Media:
- Lecture notes with additions during the lectures (Tablet-PC with projector)
- Notes based on the blackboard notes during the exercises
- small models, springs, cable, rubber foam systems
- Films and animations
- Examples with Computer Algebra Systems
- Representative examination questions along with their solutions will be made available online
- Exercise sheets with (time delayed) solutions will be made available online

Reading List:
Szabo, I., Einführung in die Technische Mechanik
Clough, R., Dynamics of Structures, Mcgraw-Hill Professional
Gross, D., Hauger W., Schröder J., Wall W. A.: Technische Mechanik, Band 1 und Band 2, Springer Verlag

Responsible for Module:
Prof. Dr.-Ing. Gerhard Müller

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

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

Module Description

BGU44011T2: Computation in Civil and Environmental Engineering 2

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
Written examination without any auxiliary means. Tasks will consist of general questions as well as computations and development of small MATLAB-programs.
There will be an ungraded student assignment consisting of 9 examination sheets where at least 75 percent have to be completed successfully.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
completion of the course "Computation in Civil and Environmental Engineering 1"
basic knowledge of a programming language (e.g. MatLAB)

Content:
- Techniques, methods, models and processes in computational civil and environmental engineering
- Linear transformations in 2D and 3D
- Time complexity of algorithms
- Sorting algorithms (bubble sort, merge sort)
- Geometric algorithms: description of curves using form functions
- Application to engineering problems by implementing a computer aided road tracking tool using clothoids and arcs
- Computation of moments for domains with curved boundaries
- Basic concepts of graph theory, algebraic operations on relations and graphs
- Applications to engineering problems (e.g.: shortest-path-search: Dijkstra-Algorithm
- (linked/unlinked) lists
- Programming of selected algorithms in MATLAB

Intended Learning Outcomes:
After completing the module students will be able to:
- estimate/evaluate the time complexity of algorithms
- use the concept of lists and sorting lists in their own programs
- understand the basics of graph theory
- compute the shortest paths in a graph
- compute an affine transformation in 2D and 3D
- use form functions to describe parametric curves
- implement engineering algorithms using a programming language

Teaching and Learning Methods:
The teaching results of the module are achieved by multiple coordinated components. The lectures are supported by PowerPoint presentations and movies illustrating computer simulations. In short blocks (five-minute-exercises) students deepen their understanding of the lecture contents. The lecture is completed by exercises in the lecture hall, where central algorithms are implemented in MATLAB. Here, methods required for completing the assignments are
demonstrated live on a computer. Exercise sheets which need to be completed successfully will be distributed and are part of a non-graded student assignment. Students work on the assignments in practical sessions where they are supported by student tutors.

Media:
PowerPoint presentations. Live demonstration of computer programs.

Reading List:
PowerPoint slides are provided in MOODLE before and after the lecture, including hand-written online - amendments.

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

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

Ernst Rank (rank@bv.tum.de)

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

Technische Universität München

Module Description

CH1090: Introduction to Organic Chemistry

Civil, Geo and Environmental Engineering

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

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

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

Repeat Examination:
Next semester

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

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

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

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

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

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

Analyze and identify:
Chromatography, TLC, GC, mass spectroscopy, IR, NMR

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

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

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

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

In-depth knowledge:
Industrial organic chemistry: pharmaceuticals, evaluation of chemical reactions: yield and atom economy, terpenes, natural resins and varnishes, drying oils, wood and paper, waxes and silicones

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

Teaching and Learning Methods:
The module consists of a lecture with accompanying exercises. The contents are taught in lecture and through presentations. Students should be encouraged to substantive discussion of the issues and to study advanced literature. Exercises are given in correlation to the lecture progress and will be discussed centrally after a given processing time.

Media:
Script, presentation, exercise sheets.

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

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

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

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

Technische Universität München

Module Description

WZ0194: Introduction to Meteorology

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
Klausur von 60 Minuten Dauer
In der schriftlichen Prüfung zeigen die Studierenden, dass sie in der Lage sind anhand theoretischer Fragen und praktischer Aufgaben in kurzer Zeit die wichtigsten Grundlagen der Meteorologie und Klimatologie wiederzugeben sowie grundständige meteorologische Berechnungen durchzuführen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse in Physik und Mathematik

Content:
Das Modul vermittelt in einer Vorlesung einen Überblick über das Fachgebiet der Meteorologie sowie der Klimatologie und grundlegende Arbeitsweisen des Faches. Inhalt: meteorologische Grundgrößen, Struktur der Atmosphäre, Zustandsgleichung für trockene und feuchte Luft, Strahlungsgesetze, Treibhauseffekt, chemische Zusammensetzung der Atmosphäre, adiabatische Prozesse, Labilität und Stabilität, globale Zirkulation, Entstehung und Eigenschaften von Fronten, Klimasystem sowie natürlicher und anthropogener Klimawandel. Zusätzlich werden meteorologische Berechnungen vorgestellt (Übungsaufgaben mit Bezug auf umweltwissenschaftliche Anwendungen)

Intended Learning Outcomes:
Die Studenten beherrschen die Grundlagen der Meteorologie und Klimatologie. Sie können selbständig meteorologische Berechnungen durchführen und sind in der Lage die Ergebnisse zu interpretieren. Die Studenten können meteorologische und klimatische Prozesse im Zusammenhang mit ihrer Umweltrelevanz beurteilen.

Teaching and Learning Methods:
Die Inhalte der Vorlesung werden im Vortrag und durch Präsentationen vermittelt. Studierende sollen zum Studium der Literatur und der inhaltlichen Auseinandersetzung mit den Themen angeregt werden. Beispielaufgaben werden zur Verfügung gestellt und teilweise besprochen.

Media:

Reading List:
z.B. Häckel, H. (2008): Meteorologie.
Klose, B. (2008): Meteorologie.

Schönwiese, C.D. (2008): Klimatologie.

Responsible for Module:
Nicole Estrella (estrella@wzw.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Meteorology (lecture, 2 SWS)
Estrella N, Menzel A

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

Technische Universität München

Module Description

BGU38017: Thermodynamics and Energy Technology

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
Der Leistungsnachweis erfolgt in Form einer 90 minütigen Klausur bestehend aus einem theoretischen Teil und einem Rechenteil.
Das Ziel der schriftlichen Prüfung ist der Nachweis, dass die thermodynamischen Zusammenhänge verstanden wurden, Zustände und einfache Zustandsänderungen grafisch und mathematisch beschrieben werden können und vereinfachte Prozesse mit Hilfe von Bilanzgleichungen analysiert werden können. Dazu müssen im theoretischen Teil Verständnisfragen zu thermodynamischen Zusammenhängen beantwortet werden. Im zweiten Teil müssen basierend auf den im Rahmen des Moduls erworbenen Lernergebnissen thermodynamische Systeme berechnet und analysiert werden.
Die Antworten erfordern teils eigene Formulierungen, teils Ankreuzen von vorgegeben Mehrfachantworten, wobei der Schwerpunkt auf kurzen Rechenaufgaben liegt.
In der Klausur sind neben Taschenrechner und Lineal keine weiteren Hilfsmittel zugelassen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
keine

Content:
¿ Grundbegriffe der Thermodynamik und thermodynamischer Systeme
¿ Allgemeine Transport- und Bilanzgleichungen: Besonderheiten von Erhaltungsgrößen
¿ Erster Hauptsatz der Thermodynamik: Energie
¿ Thermische und Kalorische Zustandsgleichungen
¿ Zustandsänderungen verschiedener Systeme (ideales Gas, inkompressibles Fluid, Nassdampfgebiet)
¿ Zweiter Hauptsatz der Thermodynamik: Entropie
¿ Wärmeübertragung
¿ Grundbegriffe der Exergie
¿ Kreisprozesse: Wärmekraftmaschinen (Gasprozesse, Dampfkraftmaschinen), Kältemaschinen, Wärmepumpen
¿ Grundbegriffe und Grundlagen Feuchter Luft
¿ Verbrennungsprozesse

Intended Learning Outcomes:
NNach erfolgreicher Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage:
¿ Die Grundbegriffe der Thermodynamik zu kennen
¿ Zustände und einfache Zustandsänderungen thermodynamischer Systeme zu verstehen und grafisch und

mathematisch zu beschreiben
¿ Energie-, Entropie- und Exergiebilanzgleichungen für einfache Prozesse aufzustellen und zu lösen
¿ Vereinfachte Kreisprozesse energetisch und exergetisch zu analysieren und zu bewerten

Teaching and Learning Methods:
Die Veranstaltung findet als Vorlesung mit integrierter Übung statt. Die in der Vorlesung vermittelten Inhalte werden durch Übungsaufgaben, die im Rahmen der Übung in Einzel- oder Gruppenarbeit bearbeitet werden, begleitet. Das eigenständige Lernen der Studierenden wird durch weitere Übungsaufgaben in Moodle unterstützt.

Media:
Präsentationen, Beamer, Tafel, Moodle

Reading List:
Wird in der Vorlesung bekannt gegeben.

Responsible for Module:
Dr.-Ing. Uwe Hübner (u.huebner@tum.de)

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

Dr.-Ing. Uwe Hübner (u.huebner@tum.de)

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

Technische Universität München

Module Description

BV000013: Hydromechanics

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The written examination of this module lasts 90 minutes. In the first 30 minutes question concerning the fundamentals of Hydromechanics need to be answered without any aids. The answers include self-made formulations, multiple choice and small calculation problems.In the following 60 minutes, in which all aids are allowed, the comprehension of hydraulic systems is examined. By solving calculation problems concerning the course's topics the students show, that they are capable to analyze hydraulic systems by applying the learned theory to distinguish the fundamental values of the problem.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The modules Technical Mechanics I (BV000001), Technical Mechanics II (BV000004), Advanced Mathematics 1 BGU (MA9517), Advanced Mathematics 2 BGU (MA9512), secondary school level knowledge in mechanics and thermodynamics

Content:
Fundamental terms of hydromechanics and fluid properties
- Hydrostatics
- Kinematics of continua
- Kinetics of continua
- Bernoulli's equation
- steady pipe flow
- steady free-surface flows

Intended Learning Outcomes:
Upon sucessful completion of this module students are able to:
- name the elementary terms of hydromechanics and fluid properties;
- explain the fundamental equations of the conservation of mass and momentum for incompressible flows (Navier-Stokes equations)
- apply the basic kinematic concepts and tensor calculations;
- employ calculation concepts on steady free-surface flows,
- compute pressure and forces in hydrostatic systems;
- analyze complex flows applying the principal of linear momentum and Bernoulli's equation within an engineering context
- compute the flow rate as well as major and minor losses in pipeline systems

Teaching and Learning Methods:
The module is structured as any classical course teaching fundamentals: lecture, exercise, tutorial / exercise sheets. In the lecture, complemented by a presentation and a skriptum, the theory is developed, supported by videos and photographs. In the subsequent exercise the contents of the lecture are recessed and applied using a fill-in-the-blank skriptum. As far as possible the exercise switches between groupwork in the lecture room and lecture by the exercise instructor. In addition exercise sheets to independly reinforce the topics are handed out. In tutoring session the students have the opportunity to discuss their solution of the exercise sheets with tutors and reflect on their actual state of knowledge during the semester. Moreover an online quiz is provided to support the reinforcement.
This tripartite structure guides the students to individually look into the theory by studying accompanied literature and reinforcing the lecture to be able to apply classical solutions as well as self-developed solutions.

Media:
slides, black/white board, scriptum, exercise sheets, eLearning material, experiments, videos

Reading List:
- lecture script
- exercise script
- J. H Spurk and N. Aksel, Strömungslehre: Einführung in die Theorie der Strömungen (Springer, 2006).
- R. C.M Schröder and U. Zanke, Technische Hydraulik (Springer, 1994).
- Bollrich, G. (2007), Technische Hydromechanik 1, Verlag Bauwesen, Berlin.

Responsible for Module:
Michael Manhart (michael.manhart@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Hydromechanics ¿ Exercise (exercise, 2 SWS)
Brosda J

Hydromechanics ¿ Tutorial (tutorial, 1 SWS)
Jenssen U, Brosda J

Hydromechanics (lecture, 3 SWS)
Manhart M, Quosdorf D, Jenssen U

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

Technische Universität München

Module Description

MA9511: Applied Mathematics BGU

Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Bachelor	German	one semester	winter semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
4	120	60	60

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

Description of Examination Method:
The module examination is based on a written exam (90 minutes). Students have to know basic concepts of Statistics, as well as Numerical Mathematics and are familiar with the calculus in these cases. They show their ability to deal with mathematical problems of structural and surveying engineering in limited time.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
MA9501 - Advanced Mathematics 1
MA9502 - Advanced Mathematics 2

Content:
Statistics: see module description MA9519

Numerical Mathematics 1: mathematical modelling; computer arithmetic; error analysis and problem condition; numerics of linear systems of equations: LU decomposition, Cholesky decomposition, QR decomposition; numerics of nonlinear systems of equations: bisection, regula falsi, secant method, fixed point iteration, Newton's method; nonlinear optimization; polynomial interpolation, spline interpolation; numerical integration; initial value problems of ordinary differential equations (introduction).

Intended Learning Outcomes:
After successful completion of the modul, students are able to understand and apply the content covered.

Teaching and Learning Methods:
lecture, exercise session

Media:
blackboard

Reading List:
Rooch, A.: Statistik für Ingenieure. Springer, 2014.
Fahrmeir, L. Heumann, C., Künstler, R., Pigeot, I. und Tutz, G.: Statistik. Der Weg zur Datenanalyse. Springer, 2016
Matthias Bollhöfer, Volker Mehrmann: Numerische Mathematik. Eine projektorientierte Einführung für Ingenieure, Mathematiker und Naturwissenschaftler, Vieweg Verlag, Wiesbaden, 2004.

Responsible for Module:
Johann, Andreas; PD Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Statistics (BGU) [MA9511, MA9519] (lecture, 2 SWS)
Haug S [L], Klüppelberg C

Numerical Methods (BGU) (Exercise Session) (exercise, 1 SWS)
Pfefferer J

Numerical Methods (BGU) (lecture, 3 SWS)
Pfefferer J

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

Technische Universität München

Module Description

BGU55027: Fundamentals of Process-oriented Planning and Organisation [GPPO]

Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Bachelor	German	one semester	winter semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
5	150	90	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:
Real Estate as object of investment; utilization and operation; infrastructure objects; phases of Real Estate Development, permission processes; cadaster; sustainability; Real Estate as physi-cal object: Standards DIN276/DIN277; procedural, descriptive, object oriented and process ori-ented models of planning; design and organization planning; realization processes, service, service of planning, HOAI, AHO; Real Estate and Construction markets; entrepreneurship, con-struction markets, division of work, participants, interfaces; theory of planning and organization; Theory of Graphs, fundamental structures; systems theory; locality and emergence; planning of production processes; sequences and dates; function of production; representations; algorithm of Ford; determination of ranks/dates; controlling processes; cybernetics; processes; controlling and production processes; network analysis; stakeholder analysis, linear cross-impact-analysis and higher order.

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, excursions

Reading List:
Detailed lecture notes

Responsible for Module:
Josef Zimmermann (j.zimmermann@bv.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Fundamentals of Process-oriented Planning and Organisation (lecture with integrated exercises, 4 SWS)
Eber W, Zimmermann J

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

Technische Universität München

Module Description
BGU67002: Geology

Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Bachelor	German	one semester	winter semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
6	180	30	60

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

Description of Examination Method:
Am Ende des Semesters wird eine 90 minütige Klausur in schriftlicher Form abgehalten, in der die Studierenden nachweisen müssen, ob sie die erlernten Grundlagen zur Entwicklung der Erde, zum Vulkanismus, zur Plattentektonik, den Kreislauf der Gesteine, die verschiedenen Gesteinstypen und Erdgeschichte verstehen und in Wissensfragen wiedergeben können. Es wird überprüft, inwieweit die Studierenden die wesentlichen Prozesse und Konzepte der Geologie, der endogenen und exogenen Dynamik in fallspezifischen Fragestellungen problemlösungsorientiert heranziehen und unterschiedliche Gesteinstypen lösungsorientiert analysieren, sowie in die geologischen und hydrogeologischen Strukturen Deutschlands einordnen können. Darüber hinaus sollen die Studierenden nachweisen, dass Sie die Prozesse, Prozessketten und Schlüsselprobleme in der Hydrogeologie verstanden haben und im Bereich der Geothermie und der Umweltgeologie Gefährdungsbilder analysieren und Lösungsvorschläge entwickeln können

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse in den Bereichen Mathematik, Chemie und Physik werden empfohlen. Die Studierenden sollten an der Geologie sowie der angewandten Hydrogeologie und Umweltgeologie interessiert sein.

Content:
¿ Entwicklung der Erde
¿ Erdbeben und Plattentektonik
¿ Vulkanismus
¿ Der Kreislauf der Gesteine
¿ Erosion und Verwitterung
¿ Gesteinsbildende Minerale und magmatische Gesteine
¿ Sedimente und Sedimentgesteine
¿ Metamorphe Gesteine
¿ Grundlagen der Erdgeschichte
¿ Übersicht der Geologie Deutschlands
¿ Gesteins-Wasser-Wechselwirkung
¿ Globale Grundwasserressourcen
¿ Geogene Belastungen des Grundwassers
¿ Anthropogene Belastungen des Grundwassers
¿ Grundwasser als Ökosystem
¿ Wasser- Spielball im Globalen Wandels
¿ Radioaktive Endlager
¿ Naturgefahren- Erdbeben, Tsunamis- Fallbeispiele, Frühwarnsysteme, Massenbewegungen

¿ Einfluss des Menschen auf den Klimawandel
¿ Die Entwicklung des Permafrosts im globalen Umweltwandel und seine Konsequenzen
¿ Geothermie zur Erzeugung von grüner Energie
¿ Wasserbau in der Praxis : Renaturierung der Salzach

Intended Learning Outcomes:
¿ Die Studierenden verstehen die Grundzüge der Entstehung und des Aufbaus der Erde
¿ Außerdem verstehen Sie die wichtigsten Prozesse in der Erde (endogen) und auf (exogen) der Erdoberfläche vor dem Hintergrund der Plattentektonik
¿ Sie haben den Kreislauf der Gesteine, die Grundzüge der Verwitterungsprozesse- und formen kennen gelernt und verstehen diese
¿ Die Studierenden sind in der Lage, sich an die Bildungsbedingungen und -räume sowie die wichtigsten Eigenschaften von magmatischen Gesteinen, Sedimentgesteinen sowie metamorphen Gesteinen zu erinnern und diese zu verstehen
¿ Sie kennen deren Umwandlung, Verformung, Verwitterung, Abtragung und Ablagerung und verstehen diese
¿ Sie verstehen die systematischen Zusammenhänge zwischen Zusammensetzung, Aufbau und Entstehung von Gesteinen und deren Eigenschaften und können diese erklären
¿ Die Studierenden sind im Stande, die unterschiedlichen Gesteinstypen zu analysieren und so voneinander zu unterschieden und deren Bildungsbedingungen und -räume zu bewerten
¿ Sie erinnern sich an die einzelnen geologischen Zeiteinheiten und deren wichtigste Charakteristika und verstehen diese
¿ Die Studierenden verstehen die geologischen Strukturen sowie die geologische Entstehung Deutschlands
¿ Sie sind in der Lage, die Bildungsbedingungen und -räume der einzelnen geologischen Einheiten und Strukturen in Deutschland zu analysieren
¿ Die Studierenden sind in der Lage die chemische Zusammensetzung der Grundwässer mit der Geologie von Bayern zu verknüpfen
¿ Die Studierenden erinnern sich an die globalen Grundwasserressourcen, kennen die wichtigsten Größen des globalen und regionalen Wasserverbrauchs und verstehen den Wassertransport in Grundwasserleitern
¿ Die Studierenden verstehen das Grundwasser als Ökosystem, seine geogenen und anthropogenen Belastungen und verstehen die Grundzüge des Selbstreinigungspotentials
¿ Sie kennen potentielle Standorte für die Lagerung radioaktiven Materials insbesondere im Kontext der Hydrogeologie am Standort, erinnern sich an die sicherheitsrelevanten Konzepte für die Genehmigung eines radioaktiven Endlagers und lernen aktuelle Forschungsergebnisse zur Endlagerung kennen
¿ Die Studierenden erinnern sich an die einzelnen Hangbewegungstypen, deren sekundäre Effekte sowie die Konzepte von Naturgefahr und -risiko und verstehen diese
¿ Sie verstehen die Zusammenhänge zwischen der räumlichen und zeitlichen Entwicklung des Permafrosts in arktischen Gebieten und Gebirgen und dem globalen Umweltwandel und erkennen an Hand von wissenschaftlichen Daten den Einfluss des Menschen auf den Klimawandel zu beurteilen
¿ Sie sind im Stande, die daraus resultierenden Folgen (z. B. Naturgefahren, Erosion, CO2-Anstieg) zu verstehen und diese Entwicklungen an ausgewählten Standorten zu analysieren
¿ Die Studierenden lernen die Bayerische Molasse als Standort für die Erzeugung grüner Energie durch das Nutzen der Erdwärme (Geothermie) kennen, erinnern sich an die wichtigsten Kenngrössen, physikalischen Prozesse und Prozessketten zur Beschreibung des Wärmetransports im Untergrund einschließlich der verschiedenen Typen von geothermischen Anlagen

Teaching and Learning Methods:
Um die angestrebten Lernergebnisse bestmöglich zu erreichen, wird auf eine Mischung aus verschiedenen Lehr- und Lernmethoden wie Vorlesung, PPT-Präsentation, Tafelarbeit und Filmmaterial zurückgegriffen. Für eine erfolgreiche Nachbearbeitung des Stoffs werden die wichtigsten Arbeitsmaterialien online bereitgestellt. Um einen frühen Einblick in das zukünftige Tätigkeitsspektrum des UI zu bekommen werden in den Vorlesungen der Umweltgeologie zahleiche Praxisbeispiele vorgestellt und in die Vorlesungen eingepflegt.
Um die einzelnen Gesteinstypen besser voneinander unterscheiden und klassifizieren zu können, werden Gesteinsproben in die Veranstaltung mitgebracht und den Studierenden die Möglichkeit geboten, nach der Veranstaltung über diese zu diskutieren und Fragen zu stellen.

Media:
Präsentation, Tafelanschrift, Gesteinsproben, Handouts mit den wichtigsten Diagrammen und Tabellen.

Reading List:
Fetter CW (2001): Applied Hydrogeology, 4th ed. Prentice Hall, New Jersey, 598 pp.
FRY, N. (1991): The field description of metamorphic rocks. Wiley-Blackwell.
JERRAM, D. & PETFORD, N. (2011): The Field Description of Igneous Rocks. Wiley-Blackwell.
MARKL, G. (2008): Minerale und Gesteine. Spektrum Akademischer Verlag.
PRESS, F. & SIEVER, R. (2008): Allgemeine Geologie: Eine Einführung. Heidelberg, Berlin, Oxford (Spektrum). [Übersetzt und herausgegeben von Volker Schweizer].
SEBASTIAN, U. (2012): Gesteinskunde. Ein Leitfaden für Einsteiger und Anwender. Spektrum Akademischer Verlag.
STANLEY, S. (1994): Historische Geologie. Spektrum Akademischer Verlag. Kapitel 3 und 4.
TUCKER, M. E. (2011): Sedimentary rocks in the field: A practical guide. John Wiley & Sons.

Responsible for Module:
Prof. Michael Krautblatter (m.krautblatter@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Environmental Geology (lecture, 2 SWS)
Einsiedl F, Krautblatter M, Wunderlich A, Zoßeder K

Introduction to Geology for Environmental Engineers (lecture, 2 SWS)
Krautblatter M, Einsiedl F, Mamot P

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

Technische Universität München

Module Description

BV000103: Basics of Process Engineering

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The module examination is a 60-minute written test.
The aim of the written test is to verify that the basic approaches to typical questions of process technology were understood and can be used for comparison. These problems must be analyzed and based on learning outcomes acquired in the course of the module, find and implement solutions in limited time.
The answers require partly own formulations, partly ticking given single or multiple answers. The focus is on short calculation tasks.
For the exam no aids are permitted except for a non-programmable calculator. Selected formulas are handed out as an attachment to the exam.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basics in mathematics, physics and chemistry are required.

Content:
The course has the following focuses:
- Introduction, overview, literature
- Mechanical PE
- Heat transfer
- Gas cleaning
- Thermal separatinf processes
- Chemical reaction engineering
+ Mass balances
+ Reactions of 0., 1. and 2. order
+ Accumulation, efficiency
- CSTR and PFR
- Reactor's analysis, non-ideal reaktors
- Transport impacts

Intended Learning Outcomes:
Students can remember different apparatus for procedural tasks, can compare their pros and cons for the concrete application, and can create simple equations for calculation and dimensioning.

Teaching and Learning Methods:
The lecture theoretical principles are first taught. Using sample tasks in the lecture, approaches are discussed and exemplified calculated. In the following exercise, the students apply the lessons learned on similar tasks and thereby internalize the approach.

Media:
Beamer, recommended literature

Reading List:
Verfahrenstechnik, Hemming/Wagner, Vogel Fachbuch, Würzburg.
Principles of Environmenatal Engineering and Science; MacKenzie, Davis / Masten, Susan
Environmental Engineering, Salvato; Joseph, A. / Nemerow, Nelson L. / Agardy, Franklin J.

Responsible for Module:
Dr.-Ing. Konrad Koch, k.koch@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Basics of Process Engineering (lecture, 2 SWS)
Koch K [L], Böhm B, Koch K

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

Technische Universität München

Module Description

BGU38015: Ecology and Microbiology

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The module examination is a 90-minutes written test. The students demonstrate that they have gained knowledge on basic principles of microbiological and ecological processes / functions and relationships. Environmental problems can be analyzed and be explained by practical examples and applications. The answers require the students own formulations, some individual terms, definitions and explanations and examples are queried. No auxiliary materials are allowed.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic chemical and bioloogical knowledge

Content:
The first part of the module deals with basic ecology: Interactions of organisms and environment as well as of species. Moreover, nutrient and energy fluxes in living communities are presented. Ecosystems and the influence of mankind are demonstrated focusing on anthropogenic emission and resource consumption, nature conservancy and biodiversity.
The second part covers the lecture microbiology. The content is basic microbiology as well as ecology of environmental microbial organisms, metabolic cycles and characterization of natural biocoenoses. Moreover, microbial indicator organisms are presented and the influence of technical and climatic changes on microbial biocoenoses. The topics are illustrated by practical examples and applications.

Intended Learning Outcomes:
After attending the lectures he students will be able to define vital ideas and concepts in both ecology and environmental microbiology. By the explanation of terms, they will gain basic understanding of ecological and microbiological relationships, in order to analyze and assess the complexity as well as the sensitivity of eco systems. The students will thus be able to independently assess environmentally safe and sustainable technical solutions.

Teaching and Learning Methods:
Lecture is the favorable teaching and learning method to provide theoretic basic knowledge of Ecology and Microbiology, Theory in combination with practical examples and application are presented and topic-depending internet links for further interest are provided.

Media:
Powerpoint, chalk board, films web-links, lecture notes

Reading List:
General basics in ecology:
Nentwig ,W., Bacher, R. und Brandl, R.:Ökologie kompakt. Spektrum Verlag (2011)

Ecological deepening:
C.R. Townsend, M.E. Begon und J.L. Harper. Ökologie. Spektrum Verlag (2009)
Smith, T. M. und Smith, R. L.: Ökologie. Person Studium Verlag (2011)
Grundlagen Umweltmikrobiologie
Reineke, W., Schlömann, M.: Umweltmikrobiologie. Spektrum Akademischer Verlag, Elsevier (2007)
Maier, R., Pepper, I., Gerba, C.: Environmental microbology. Academic Press, Elsevier (2009)
Microbiological deepening:
Fuchs, G.: Allgemeine Mikrobiologie. 8. Aufl., Thieme Verlag Stuttgart (2007)
Madigan, M.T., Martinko, J.M.: Brock Biology of Microorganisms. 11.Aufl. Pearson Prentice Hall, Upper Saddle River NJ 07458 (2006)

Wastewater treatment
Kunst, S., Mudrack, K. : Biologie der Abwasserreinigung. 5. Auflage, Spektrum Akademischer Verlag Heidelberg (2003)

Limnological ecology:
Lampert, W., Sommer, U.: Limnoökologie. 2. Aufl., Thieme

Responsible for Module:
Dr. Elisabeth Müller (Ökologie), e.mueller@tum.de
Prof. Dr. Hilde Lemmer (Mikrobiologie), lemmer@oec.net

Courses (Type of course, Weekly hours per semester), Instructor:
Basics of Ecology (lecture, 2 SWS)
Wurzbacher C [L], Wurzbacher C

Microbiology (lecture, 2 SWS)
Wurzbacher C [L], Wurzbacher C

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

Technische Universität München

Module Description

BGU47024T3: Photogrammetry, Remote Sensing and Geographic Information Systems

Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Bachelor	German	two semesters	winter semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
9	270	180	90

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

Description of Examination Method:
Die Lernergebnisse des zweisemestrigen Moduls werden in zwei schriftlichen Teilprüfungen abgefragt: Einer 60-minütigen Klausur im ersten und einer 120-minütigen Klausur am Ende des zweiten Modulsemesters. Die Antworten erfordern teils eigene Formulierungen, teils Ankreuzen von vorgegeben Mehrfachantworten. Hilfsmittel sind nicht zugelassen. Die beiden Klausuren gehen im Verhältnis ihres Umfangs (GIS 1: 1/3; GIS2+PF1: 2/3) in die Modulnote ein. Die Aufteilung der Modulprüfung ist erforderlich, um die Prüfungsbelastung für die Studierenden am Ende des zweisemestrigen Moduls zu verringern.
Dabei werden die Lernergebnisse wie folgt nachgewiesen: Anhand der ersten Klausur wird überprüft, ob die Studierenden die theoretischen Grundlagen der räumlichen Modellierung und Datenstrukturen sowie Modellierungsmethoden und Algorithmen verstehen und präzise darlegen können. In der zweiten Klausur wird dann geprüft, inwieweit die Studierenden fallspezifisch die richtigen Datenerfassungs- und Analysemethoden aus der Photogrammetrie und Fernerkundung bzw. der Geoinformatik heranziehen und die Anwendung anhand konkreter Problemstellungen korrekt darlegen können. Sowohl das Beherrschen der theoretischen Grundlagen räumlicher Modellierung als auch die professionelle Anwendung von Datenerfassungs- und Analysemethoden in der Geoinformatik sind als übergreifende Kompetenzen des Umweltingenieurs unerlässlich für die berufliche Qualifikation. Ungeachtet der jeweiligen Spezialisierung gehört es zum grundlegenden Rüstzeug des Umweltingenieurs, die Methoden zur Erfassung, zur Modellierung, zum Analysieren und Visualisieren von Umweltdaten heranziehen und algorithmisch umsetzen zu können.. Ebenso müssen Umweltingenieure die Verfahren und Methoden zur Gewinnung von umweltbezogenen Daten genau verstehen, sowie grundlegende Methoden ihrer Verarbeitung und Analyse, etwa zum Zweck des Umweltmonitorings und des Risikomanagements anwenden können. Um sowohl die theoretischen Grundlagen von Datenstrukuren als auch die Anwendung konkreter Datenerfassungs- und Analysemethoden in diesem grundlegenden Fach sicherzustellen, müssen die Studierenden somit beide Modulteilleistungen erfolgreich bestehen.
Inwieweit die Studierenden komplexe GIS-Software in der Praxis für die Analyse räumlicher Modellierung und Datenstrukturen sowie zur Erfassung und Analyse von räumlichen Daten selbständig anwenden können, wird anhand einer zusätzlichen Studienleistung in Form von je 5 semesterbegleitenden AAufgaben pro Semester nachgewiesen, zumal der Umgang mit der Spezialsoftware nicht adäquat in den Klausuren überprüft werden kann. Dabei werden die Aufgaben am PC bearbeitet, unter Betreuung von Tutoren. Hierzu stehen insgesamt 20 Präsenzstunden und 40 Eigenstudiumsstunden zur Verfügung.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlagen in Informatik

Content:
- räumliche Modellierung und Datenstrukturen
- Modellierungsmethoden und Basisalgorithmen in der Geoinformatik
- Methoden zur Erfassung und Analyse von räumlichen Daten aus den Bereichen Geoinformatik, Photogrammetrie und Fernerkundung
- Einsatz von GIS-Software in der Geoinformatik zur Analyse von räumlichen Daten

Intended Learning Outcomes:
Nach erfolgreichem Absolvieren des Moduls sind die Studierenden in der Lage, die Grundlagen der räumlichen Modellierung und Datenstrukturen mit den zugehörigen Modellierungsmethoden und Basisalgorithmen zu verstehen. Aufbauend auf diesen Grundlagenkönnen die Studierenden die Methoden zur Erfassung und Analyse von räumlichen Daten aus den Bereichen Geoinformatik, Photogrammetrie und Fernerkundung anwenden. Die Studierenden können komplexe GIS-Software in der Praxis für die Analyse räumlicher Modellierung und Datenstrukturen sowie zur Erfassung und Analyse von räumlichen Daten selbständig anwenden

Teaching and Learning Methods:
Vorlesungen:
-Die theoretischen Grundlagen und die Methodik der Modellierung und Datenstrukturen in der Geoinformatik, Photogrammmetrie und Fernerkundung werden in den Vorlesungen in Form eines Vortrages mit Präsentationen von (?) vermittelt.
Übungen:
Konkrete, fallspezifische Fragestellungen zu räumlicher Modellierung und Datenstrukturen sollen problemlösungsorientiert bearbeitet werden.
- Üben von technischen Fertigkeiten: In begleitenden Übungen werden praktische Fertigkeiten im Umgang mit Geoinformationssystemen (GIS) am Computer erlernt.

Media:
Präsentationen, E-Learning System (Moodle), GIS-Software

Reading List:
wird im Rahmen der Lehrveranstaltungen bekannt gegeben

Responsible for Module:
Thomas H. Kolbe

Courses (Type of course, Weekly hours per semester), Instructor:
Labs in Geoinformatics 2 (exercise, 1 SWS)
Elfouly M (Willenborg B), Nguyen H

Photogrammetry and Remote Sensing 1 (lecture, 2 SWS)
Hoegner L [L], Stilla U

Geoinformatics 2 (lecture, 1 SWS)
Kolbe T (Elfouly M, Willenborg B)

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

Technische Universität München

Module Description

BGU54007: Environmental Monitoring and Risk Management

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
In der 120-minütigen schriftlichen Klausur ist der Nachweis, inwieweit die Studierenden die theoretischen Grundlagen und Anwendungen der Umweltmonitoring, Geostatistik und des Risikomanagement verstanden haben und in begrenzter Zeit wiedergeben können.
Die Antworten beziehen sich auf Textaufgaben und Rechenaufgaben im Bereich Umweltmonitoring, Geostatistik und Risikomanagement. Ferner sollen die Studierenden in der Lage sein Problemstellungen zu erkennen, analysieren und anschließend zu lösen.
In der Klausur sind keine Hilfsmittel zugelassen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlegendes Verständnis für Mathematik, Statistik und Physik

Voraussetzungen für Umweltingenieure:
Höhere Mathematik 1 und Höhere Mathematik 2, angewandte Mathematik, Meteorologie

Content:
Die Vorlesungsreihe ist aufgeteilt in 3 Kapitel:
Umweltmonitoring:
¿ Einführung in das Umweltmonitoring
¿ Monitoring der Luftqualität
¿ Messung meteorologischen Größen
¿ Einführung in der Bodenkunde und in der Bodenerosion inclusive Bodenmessungen
¿ Quantitatives und qualitatives Gewässermonitoring

Geostatistik:
¿ Korrelationsanalyse
¿ Regressionsrechnung
¿ Einführung in die Geostatistik
¿ Variogramme
¿ Das Kriging Verfahren
- Ordinary Kriging
- Block Kriging
- External Drift Kriging
- Indikator Kriging

Risikomanagement:
¿ Risikoanalyse-Konzept
¿ Propagation von Unsicherheiten durch Modelle
¿ Bestimmen von Systemzuverlässigkeiten
¿ Weitere ausgewählte Aspekte der Statistik und Wahrscheinlichkeitstheorie
¿ Entscheidungsanalyse
¿ Risikobewertung und -akzeptanz

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung können die Studierenden Zustandsgrößen und Flüsse in verschiedenen Umweltmedien (Boden, Wasser, Luft) bemessen, monitoren, analysieren und darüber hinaus auch bewerten. Das Modul versetzt die Studierenden außerdem in die Lage, anspruchsvolle Analyseaufgaben selbständig durchzuführen, um z.B. räumliche oder zeitliche Trends in statistischen Daten zu bewerten. Hierfür können sie unterschiedliche geostatistische Kriging-Verfahren sicher anwenden, unterscheiden und bewerten. Schließlich sollen die Studierenden in der Lage sein, mittels Modellen und den aus Daten gewonnenen statistischen Aussagen einfache probabilistische Vorhersagen zu ermitteln und damit Risikoabschätzungen durchzuführen. Die Studierenden sollen dabei eine kritische Grundhaltung gegenüber Datensammlung und Datenbearbeitung entwickeln.

Teaching and Learning Methods:
Das Modul besteht aus einer Vorlesungsreihe bestehend aus Theorie und Übungen.
Die Inhalte der Vorlesung werden im Vortrag und durch Präsentationen vermittelt. Studierenden sollen zum Studium der Literatur und der inhaltlichen Auseinandersetzung mit den Themen angeregt werden. In den Übungen werden konkrete Fragestellungen beantwortet und vertieft.

Media:
Skriptum
Übungsblätter
Powerpoint-Präsentation
Tafelarbeit

Reading List:
Wird vorlesungsbegleitend ausgegeben.

Responsible for Module:
Prof. Dr.-Ing Markus Disse (markus.disse@tum.de)

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

Prof. Dr.-Ing Markus Disse (markus.disse@tum.de)
Prof. Dr.sc.tech. Daniel Straub (daniel.straub@tum.de)
Dr.-Ing. Wolfgang Rieger (wolfgang.rieger@tum.de)

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

Technische Universität München

Module Description

BGU53035T2: Surveying for Environmental Engineering

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
In an 90-minutes written exam it is examined, to which extent students are capable of understanding the basic principles geodesy, observation techniques, geodetic calculations and instrument composition and if they can recall them in a compacted way. Students additionally must apply known solutions to practical geodetic and calculation problems within limited time. Questions need to be answered with own words or consist of arithmetic problems to solve . As resources a non-programmable calculator is permissible.
Practical competences for simple tasks are proven in two courseworks (4 half-day field exercises during lecture period and a project week after lecture period), when previously known tasks have to be fulfilled under supervision. By that means, students get used to operate geodetic instruments.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
- Instruments: theodolites, EDM, tacheometers, terrestrial laser scanners, levels, GNSS receivers
- observation techniques: angular and distance measurements, height measurements, satellite positioning systems, baseline measurements
- earth shape, reference systems, projections, coordinate systems, official geo-data, coordinate calculation methods (sections, traverses), alignment, earth masses, accuracy considerations

Intended Learning Outcomes:
After applying the module courses students are able to understand the composition and working principles of geodetic instruments und to use basic geodetic observation techniques. Furthermore, students understand the main limiting factors on accuracy and how to avoid them. They understand geodetic basics, are able to classify geo-data, use basic evaluation methods and analyze project designs.

Teaching and Learning Methods:
Basic composition and working principles of geodetic instruments as well as theoretical background of observation techniques and coordinate calculation are taught in a lecture, using recapitulatory lecture notes and calculation examples. Practical usage und explicit evaluation examples can be practiced in four half-day field exercises and an additional project week at the end of the module in small groups.

Media:
lecture notes, exercise notes

Reading List:
Kahmen: Angewandte Geodäsie - Vermessungskunde

Witte/Schmidt: Vermessungskunde und Grundlagen der Statistik für das Bauwesen

Resnik/Bill: Vermessungskunde für den Planungs-, Bau- und Umweltbereich

Responsible for Module:
Thomas Wunderlich (th.wunderlich@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung Vermessungskunde 1 SWS
Übungen Vermessungskunde 1 SWS
Projektwoche Hauptvermessungsübung 3 SWS
Vorlesung Geodätische Grundlagen 2 SWS
Thomas Wunderlich, th.wunderlich@tum.de
Wolf Barth, w.barth@tum.de
Glennfried Preuß, g.preuss@tum.de
Peter Wasmeier, p.wasmeier@tum.de
Christoph Reith, ch.reith@tum.de
Katharina Fuchs, k.fuchs@tum.de
Wolfgang Wiedemann, w.wiedemann@tum.de

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

Technische Universität München

Module Description

BV000108: Soil Mechanics and Foundation Engineering Basic Module for Environmental Engineers [GB GM UI]

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
Proof of performance takes place in the form of a 90 minute written exam.
The exam divided into two parts:
The first approx. 30 minute part consists of general questions with unrestricted formulations. In this part no aids (only pens, set square, compass) are allowed. It will be proven, that the students have developed an understanding for the convayed fundamental soil mechanical relationships within the scope of the module. These include:
- Elementary subsoil properties
- Subsoil investigation, subsoil description, modelling
- Classification of soil
- Shear strength of soil

The focus of the answers in this part lies on individual shorthand formulations. In part, small calculation problems must also be solved.
A second approx. 60 minute part consists of calculations and dimensioning tasks. As an aid all study documents, literature and a basic academic calculator are allowed. It will be proven, that students are capable of analysing and solving geotechnical calculations in a limited amount of time. These include:

- Design of groundwater control systems
- Calculation of groundwater flow processes
- Investigation of slope stability
- Stress and settlement calculations

The answers in this part require extensive calculations. In part, short individual formulations are necessary.
The final grade is compsed of the respective time emphasis.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The following modules should be passed: (Notice: The contents of the modules can be found in the respective module manuals (handbooks).)
- Technical Mechanics I (BV000001)
- Technical Mechanics II (BV000004)
- Advanced Mathematics I (MA9517)
- Advanced Mathematics II (MA9512)

Content:
- formation and composition of rock
- fundamental properties of subsoil
- subsoil investigation, subsoil description, modelling
- classification of soil
- soil as a construction material
- groundwater (groundwater flow, groundwater lowering)
- deformation of subsoil (propagation of stresses, settlement, consolidation)
- shear strength
- fundamentals of geotechnical design and construction
- slope stability

Intended Learning Outcomes:
After participating the module the student is able to
- evaluate basic soil properties on the basis of depicted soil parameters.
- name soil samples.
- analyse laboratory tests for extraction of soil properties.
- realize processes of groundwater flow, evaluate and analyse them.
- design groundwater control systems.
- predict and evaluate deformation of soil due to propagation of stress.
- realize and calculate processes of consolidation.
- understand and evaluate the essential strength properties of soils.
- realize and evaluate possible slope failures.

Teaching and Learning Methods:
The lecture is intensively assisted by a PowerPoint presentation, whereby the students can directly profit from the experience of the lecturer. In part, demonstration materials for a better illustration of the lecture facts will be handed out. Films concerning experiments and procedures are integrated, as well as an excursion to a reachable construction site. The contents of the lecture are deepened by exercise courses. During the exercises lecture notes to be completed by the students are used to deepen the topics of the lecture with calculation examples. For better understanding 5 term papers are handed out, which can be used for practice voluntarily outside of the attendance phase. Tutorials are offered by students to support the solving of the term papers.

Media:
lecture notes, Powerpoint-presentation, field trips, blackboard, demonstration lab tests, films

Reading List:
VOGT, N. lecture notes "Studienunterlagen Grundbau und Bodenmechanik"
KOLYMBAS, D. (1998): Geotechnik - Bodenmechanik und Grundbau; Springer-Verlag (Univ. Innsbruck)
LANG, HUDER, AMANN (2003): Bodenmechanik und Grundbau,Springer Verlag (ETH Zürich)
SCHMIDT, H.-H. (2001): Grundlagen der Geotechnik Verlag Teubner

Responsible for Module:
Akad. Dir. Dr.-Ing. Dirk Heyer, dirk.heyer@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung 2 SWS
Übung 2 SWS
Akad. Dir. Dr.-Ing. Dirk Heyer, dirk.heyer@tum.de
Stefan Huber M.Sc., s.huber@tum.de

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

Required Electives

Technische Universität München

Required Selectives of Water Engeneering

Technische Universität München

Module Description

BGU54006: Hydrology Basic Module

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
In der 90-minütigen schriftlichen Klausur wird nachgewiesen, inwieweit die Studierenden die theoretischen Grundlagen des Wasserkreislaufs, der quantitativen Hydrologie, der Extremwertstatistik, des Hochwasserrisikomanagements sowie der Niederschlag-Abfluss-Modellierung verstehen und unter Zeitdruck wiedergeben können.
Die Antworten beziehen sich zum einen auf theoretische Fragen, basierend auf den Lernergebnissen des Moduls, und zum anderen auf Rechenaufgaben zur Anwendung anerkannter hydrologischer und statistischer Methoden sowie geeigneter Bemessungsverfahren. Die Studierenden sollen in der Lage sein, das Problem zu erkennen und anschließend zu lösen.
In der Klausur sind keine Hilfsmittel zugelassen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlegende Kenntnisse in Höherer Mathematik, Statistik und Physik
z.B. Module des Bachelorstudiengangs Umweltingenieurwesen:
Höhere Mathematik 1 und Höhere Mathematik 2, angewandte Mathematik, Meteorologie

Content:
Theorie und Berechnungsmethoden zu den verschiedenen Prozessen des Wasserkreislaufs:
- Niederschlag: Niederschlagsbildung, räumliche und zeitliche Variabilität, Niederschlagsmessung, Gebietsniederschlag
- Verdunstung: Arten der Verdunstung, Messung der Verdunstung, Berechnungsmethoden
- Infiltration: Einflussfaktoren, charakteristische Kennwerte, Saugspannungs-Sättigungs-Beziehung, Messmethoden
- Wasserfluss in der ungesättigten Bodenzone (Richards-Gleichung)
- Schneehydrologie: Schneeakkumulation, -metamorphose und -ablation
- Grundwasser: Vorkommen, Grundwasserneubildung, Grundwasserströmung

Beschreibung und Quantifizierung der Abflussprozesse:
- Abflussbildung: Effektivniederschlag, Gesamtabflussbeiwert, zeitlich verteilter Abflussbeiwert
- Abflusskonzentration: Konzentrationszeit, Isochronenmodell, Einzellinearspeicher, lineare Speicherkaskade
- Gerinneabfluss: Abflusshysterese, Muskingum-Verfahren, Kalinin-Miljukov-Verfahren

Grundlagen der hydrologischen Statistik:
- Wasserwirtschaftliche Kennwerte und gewässerkundliche Hauptzahlen
- Datengrundlage, Überprüfung der Stichprobe
- Anwendung von Verteilungsfunktionen
- Statistische Testverfahren

Gesetzliche Grundlagen
- Bedeutung der EG Wasserrahmenrichtlinie (EG-WRRL)
- Bedeutung der EG Hochwasserrisikomanagement Richtlinie (EG-HWRM-RL)
Hochwasserschutz und Hochwasserrisikomanagement:
- Definitionen und Begriffe
- Bemessung und Berechnung von Hochwasserrückhaltebecken
Hydrologische Modellierung:
- Arten, Zielstellung, Datengrundlage und Aufbau unterschiedlicher hydrologischer Modelle
- Anwendung eines einfachen konzeptionellen hydrologischen Modells
- Vorstellung eines komplexen physikalisch basierten hydrologischen Modells

Intended Learning Outcomes:
Nach der Teilnahme des Grundmoduls Hydrologie sind die Studierenden in der Lage,
- die theoretischen Grundlagen, Prozesse und Zusammenhänge des Wasserkreislaufs, des Niederschlag-Abfluss-Prozesses, der Schnee- und Bodenhydrologie sowie der Hochwasserentstehung zu verstehen.
- die Zielstellung, theoretischen Grundlagen und Methoden der hydrologischen Statistik zu verstehen.
- Berechnungsverfahren zur Quantifizierung der Wasserhaushalts- und Abflusskomponenten, zur Ermittlung extremer Abflüsse sowie zur Bemessung von Hochwasserschutzmaßnahmen anzuwenden.
- ein einfaches hydrologisches Modell anzuwenden und mit ihm hinsichtlich seiner Parametrisierung zu experimentieren.

Teaching and Learning Methods:
Das Modul wird als Vorlesung abgehalten, welche für jeden Themenabschnitt aus einem Theorieteil zur Wissensvermittlung durch Frontalunterricht und Diskussion besteht, dem ein Übungsteil zur beispielhaften und praxisorientierten Anwendung der theoretischen Grundlagen folgt.
Die Inhalte der Vorlesung werden im Vortrag und durch Präsentationen vermittelt. Hierbei werden die Studierenden zum Studium der empfohlenen Literatur und der inhaltlichen Auseinandersetzung mit den Themen angeregt.
In den Übungen werden themenbezogene Probleme gelöst und konkrete Fragestellungen beantwortet.

Media:
- Skriptum
- Übungsblätter
- Powerpoint-Präsentation
- Tafelanschrieb

Reading List:
- Dyck/Peschke 1995 : Grundlagen der Hydrologie ISBN 3-345-00586-7
- Maniak 1997: Hydrologie und Wasserwirtschaft ISBN 3-540-63292-1
- Baumgartner/Liebscher 1996: Allgemeine Hydrologie ISBN 3-443-30002-2
- Plate 1993: Statistik und angewandte Wahrscheinlichkeitslehre für Bauingenieure ISBN 978-3-433-01073-0

Responsible for Module:
Dr.-Ing. Wolfgang Rieger (wolfgang.rieger@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Hydrology Basic Module (lecture, 4 SWS)
Disse M [L], Disse M, Teixeira Leandro J

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

Technische Universität München

Module Description

BV000030: Hydraulic and Water Resources Engineering Basic Module

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
Mit der schriftlichen Klausur wird geprüft, inwieweit die Studierenden die grundlegenden Konzepte wasserbaulicher und wasserwirtschaftlicher Planung in begrenzter Zeit komprimiert wiedergeben können, sowie Lösungen zu Anwendungsproblemen des konstruktiven Wasserbaus auch unter zeitlichem Druck aufzeigen können. Hilfsmittel sind nicht zugelassen außer ein nicht programmierbarer Taschenrechner und eine in der Prüfung ausgehändigte Formel- und Grafik/Tabellensammlung.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in Mathematics and Physics

Content:
The main goal in this module is to give an overview in the main aspects of water resources management and hydraulic engineering.

Precipitation and Runoff processes will be explained and also stochastic methods to determine flood frequencies for flood management.

Several water projects will be explained e.g. the planning and building of dams and weirs. Flood polders, flood retention basins, dikes (levees) will also be explained.

River engineenring problems like bedload and sediment transport will be mentioned in basics.

The German DIN-norm and other water relevant rules will be presented.

During summer semester a one-day excurion to an actual water project will be conducted.

Intended Learning Outcomes:
The students will understand the basic elements and features in water resources management and hydraulic engineering. The will be able to plan simmple projects in river and dam engineering.

Teaching and Learning Methods:
Die Vorlesungen werden durch Tafelarbeit undPowerPoint-Präsentationen unterstützt, um so den Studierenden die angesprochenen Problematiken möglichst einprägsam näher zubringen. Durch eingestreute Übungsstunden erhalten die Studierenden die Gelegenheit, den Stoff an praktischen Beispielen intensiver zu verstehen und

besondere Problemfälle zu erkennen. In Ergänzung zu Vorlesung und Übung werden freiwillig zu bearbeitende Aufgabenblätter angeboten, in denen der Stoff vertieft und geübt wird. Anschauliche Beispiele bereits gebauter wasserbaulicher Anlagen, sowie die Auseinandersetzung mit Schadensfällen, die bei Wasserbauprojekten weltweit aufgetreten sind, ergänzen den Vorlesungsstoff. Hier wird durch Diskussion versucht, Lösungsansätze zur Schadensvermeidung zu finden und Best Practise Beispiele herauszuarbeiten.

Media:
German Script
Excursion
Visit of the HydroLab in Obernach
Powerpoint Presentation
Blackboard work
Videos

Reading List:
"Wasserbau: Grundlagen, Gestaltung von wasserbaulichen Bauwerken und Anlagen",
von Heiz Patt und Peter Gonkowski, Springer Verlag, Berlin, 2011

"Wasserbau: Aktuelle Grundlagen, neue Entwicklungen",
von Theodor Strobl und Franz Zunic,
Springer Verlag, Berlin, 2006

Responsible for Module:
Prof. Dr. Peter Rutschmann (peter.rutschmann@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Hydraulic and Water Resources Engineering Basic Module (lecture, 4 SWS)
Rutschmann P

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

Technische Universität München

Module Description

BGU38016: Sanitary Engineering and Water Quality Basic Module

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The exam consists of general questions and calculations.
In the written exam students demonstrate by answering questions the theoretical knowledge of water supoply, sewer systems, wastewater and sewage sludge treatment. By doing calculations they show that they are able to create calculation tasks in this topics.
The answers requires wording but also multiple choice tests are involved. Focus are calculations.
For the first part ¿general questions¿ (duration 30 min) tools are not allowed, for the second part ¿calculations¿ (duration 90 min) the use of a calculator and all powerpoint slides form the lecture are allowed in the written exam

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in chemistry, biology and physics is util

Content:
The lecture deals with parameters for the evaluation of water and wastewater samples. Water supply basics (demand, consumption, hauling, storage, distribution) are covered. Moreover principles of wastewater treatment are discussed (bioprocess techniques, mechanical and biological treatment, design of activated sludge systems). Also slude dewatering and treatment are in the focus of the lecture.

Intended Learning Outcomes:
The students will be able to design wastewater treatment as well as water supply units. Based on the wastewater composition they will be able to determine necessary treatment processes.

Teaching and Learning Methods:
Lecture with Powerpoint and Board. Deepening of the knowledge with exercises.

Media:
Board, Beamer, Script

Reading List:
Gujer, Willi ((2007): Siedlungswasserwirtschaft, Springer Verlag Berlin

Responsible for Module:
Brigitte Helmreich (b.helmreich@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Urban Water Systems Engineering Base Module (lecture with integrated exercises, 4 SWS)
Helmreich B [L], Helmreich B, Koch K

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

Technische Universität München

Required Selectives of Transport Management

Technische Universität München

Module Description

BGU40027: Spatial Planning and Land Tenure Basic Module

Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Bachelor	German/English	one semester	winter semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
5	120	60	60

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

Description of Examination Method:
Die Modulleistung wird in einer schriftlichen Prüfung in Form einer Klausur erbracht.
Ohne Hilfsmittel sollen die Studierenden Regelungen und Vorgehensweisen der Raumplanung und Raumentwicklung wiedergeben und in eigenen Formulierungen nachweisen, dass sie die Komplexität räumlicher Planung verstanden haben und Zusammenhänge erläutern können. In Fragen zu Beispielfällen soll das erlernte Wissen praktisch angewandt werden können. Die Studierenden sollen nachweisen, dass sie die Bedeutung des Eigentumsbegriffs verstanden haben, Grundbegriffe aus dem Bereich der Bodenpolitik in eigenen Formulierungen erläutern können und an praktischen Beispiele im Zusammenhang von Bodenpolitik, Bodenrecht und Bodenordnung anwenden können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
keine

Content:
Grundzüge der Räumlichen Planung (deutsch):
A) Grundlagen
-- Anlass, Zweck und Ziel räumlicher Planung
-- Definition von räumlicher Planung, Raumordnung und Raumentwicklung
B) Raumordnung: Strukturen, Abläufe und
- Instrumente in Deutschland und Europa
-- Planungsebenen, Planungsprinzipien, Gesetzliche Grundlagen
-- Europäische Ebene und Bundesraumordnung
-- Die Landesplanung - Aufgaben und Instrumente, das Raumordnungsverfahren
-- Die Regionalplanung - Inhalte und Aufgaben am Beispiel der Region München
-- Die kommunale Bauleitplanung ¿ Aufgaben und Vorgehensweisen am Beispiel der Stadt München
C) Raumentwicklung: Informelle Planung und Beteiligung
-- Beteiligung in Planungsprozessen ¿ Anlass, Ziel und Vorgehensweise
-- Formelle und informelle Planung ¿ Ziele, Vorgehensweisen, Wechselwirkungen
-- Informelle Planung in der Praxis: Beispiele (Planungsbüro und Kommune)

Bodenrecht und Bodenordnung (englisch):
In der Vorlesung erfolgt eine detaillierte Einführung und Auseinandersetzung in den Bereichen Bodenpolitik, Bodenrecht und Bodenordnung mit folgenden Themen:
-- Begriff und Bedeutung des Bodens
-- Entwicklungslinien des Eigentums an Grund und Boden

-- Eigentumsrecht
-- Inhalt und Schranken des Eigentums
-- Grundlagen der Enteignung
-- Definition Bodenrecht
-- Grundbuch- und Grundstücksrecht

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung kennen die Studierenden gesetzliche Grundlagen, Planungsprinzipien und Instrumente räumlicher Planung. Sie sind in der Lage, Planungsabläufe in Raumordnung und Raumentwicklung zu beschreiben, komplexe Planungsprozesse zu verstehen und fachübergreifende Zusammenhänge räumlicher Planungen zu diskutieren. Sie können Planungsbeispiele in den räumlichen und fachlichen Kontext einordnen und theoretische Erkenntnisse auf die Praxis anwenden. Sie verstehen die umfassende Bedeutung des Eigentumsbegriffs und sind in der Lage, Grundbegriffe aus dem Bereich der Bodenpolitik sowie praktische Beispiele im Zusammenhang von Bodenpolitik, Bodenrecht und Bodenordnung anzuwenden.

Teaching and Learning Methods:
Lehrformat: Vorlesung
Methoden Räumliche Planung: interaktiver Vortrag mit Präsentation zur Vermittlung von Wissen, ergänzt durch Kleingruppenarbeit zur Vertiefung des Gehörten und Formulierung von offenen Fragen
Veranschaulichung der Theorie durch Beispiele aus der Praxis vorgetragen durch Gastreferenten
Methoden Bodenrecht und Bodenordnung: interaktiver Vortrag mit Präsentation zur Vermittlung von Wissen
Die Lehrmethoden sind auf die Lernaktivitäten Materialrecherche, Studium von Literatur und Auswendiglernen ausgerichtet.

Media:
- Power Point Präsentation
- Vorlesungsskript

Reading List:

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

Courses (Type of course, Weekly hours per semester), Instructor:
Basic Elements of Spatial Planning (lecture, 2 SWS)
de Vries W [L], Bendzko T

Land Tenure and Land Readjustment (lecture, 2 SWS)
de Vries W [L], de Vries W

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

Technische Universität München

Module Description

BV000029: Traffic Engineering and Transport Planning Basic Module [GM VTP]

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The examination has the form of a written 120-minute test. In a general 30-minute part, (closed book) comprehension questions are asked. Students show in this part that they can define important terms from traffic engineering and transport planning. In a 90 -minute calculation part (open book) students demonstrate that they know the design procedures for road infrastructure and can carry out the design for basic urban spaces according to the current guidelines and regulations.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Cybernetics of planning processes

Content:
Land use and transportation: mobility planning, spatial planning/zoning, transportation supply planning, transportation demand, transportation modes, traffic flow on road network, design of two-lane rural road stretches, design of uncontrolled intersections, design of controlled intersections, layout design of the street space for private transportation, layout design of the street space for public transportation, traffic noise pollution, traffic air pollution

Intended Learning Outcomes:
After completing the module, students are able to evaluate the fundamental relationships between transport supply, spatial structure and travel demand; to understand spatial development and the directive possibilities of spatial planning; to implement travel demand modeling methods as well as methods for selecting to appropriate transportation capacities (road and intersection/track and station); to evaluate the quality and performance of transport services and to analyze the impact of traffic on local conditions, the environment and society.

Teaching and Learning Methods:
The course consists of a combination of lectures and tutorials. The basic principles are taught first in the lectures and are then illustrated with examples during the tutorials. Students are able to actively increase their understanding of the material by working on similar exercises independently. Questions will be discussed in the lecture / tutorial. In addition, selected guest speakers will hold lectures to provide a direct insight into the application of the basic principles.

Media:
Presentations, detailed course notes, blackboard, film and software examples, exercises with solutions, exercises for individual practice

Reading List:
Course notes Busch / Wulfhorst: Traffic Engineering and Transport Planning Basic Module
Schnabel/Lohse: Grundlagen der Straßenverkehrstechnik und der Verkehrsplanung (Principles of Traffic Engineering and Transport Planning), publisher for civil engineering

Responsible for Module:
Univ.-Prof. Dr.-Ing. Fritz Busch (fritz.busch@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Traffic Engineering and Transport Planning Basic Module (exercise) (exercise, 2 SWS)
Busch F [L], Dumler K (Spangler M), Kinigadner J, Pajares E, Pfertner M

Traffic Engineering and Transport Planning Basic Module (lecture) (lecture, 2 SWS)
Busch F [L], Wulfhorst G (Kinigadner J, Pajares E, Pfertner M), Dumler K (Spangler M)

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

Technische Universität München

Module Description

BV000028: Road, Railway and Airfield Construction Basic Module [GK VWB]

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The 90 minute written exam will examine the extent to which students have understood the theoretical fundamentals of the transportation infrastructure in terms of alignment, cross section design and superstructure construction and are able to apply.

The examination consists firstly of a written part (45 min without additives), in which the students should remember the fundamentals. The answer requires some own formulations, some sketches and to a lesser extent ticking given multiple answers.
In a second part (45 min , with tools), students should apply their practical skills in the alignment, based on the handling of specific case study. The weighting of the two parts of the exam is 50 %

In order to examine the competences in designing road alignments under realistic conditions ¿ which cannot be conducted within the limited time of a written exam ¿ a not graded compulsory exercise is required. Supported by tutorials the students perform a major road design task, in which they apply the methods taught in the lectures.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Alignment and Cross section-layout of road and track, earthworks, drainage systems, superstructure of roads and railway
Seminar work in road design (vertical and horizontal alignment)

Intended Learning Outcomes:
At the end of the module students are able to understand the basic principles of road and railway superstructure. They are able to apply the alignment and layout criteria, based on the handling of specific case study.

Teaching and Learning Methods:
This module is splitted in lecture /presentation of the basic topics and an excercise course of road alignment. With support of the exercise course and tutorials the students create their seminar work in road design while meeting a given deadline.

Media:
Script, powerpoint presentation, white board, etc.

Reading List:
Freudenstein, St.: Grundkurs Verkehrswegebau

Responsible for Module:
Stephan Freudenstein (stephan.freudenstein@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Road, Railway and Airfield Construction Basic Module Lecture (lecture, 2 SWS)
Freudenstein S

Road, Railway and Airfield Construction Basic Module (exercise, 2 SWS)
Freudenstein S [L], Freudenstein S, Feurig S, Stahl W, Wastlhuber T

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

Technische Universität München

Required Selectives of Energy and Buildings

Module Description

BV000011: Building Physics Basic Module

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
Proof of performance is provided in the form of a written examination. The students should prove that the basic phenomena of building physics can be compiled, have been understood, can be presented in compressed form and procedures for evaluation can be applied. This implies basic principles of thermodynamics, moisture protection, sound insulation, lighting technology, thermal indoor climate, fire protection and urban microclimate. They should create analytical solutions to problems from the mentioned subjects under time pressure. 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:
Next semester

(Recommended) Prerequisites:
none

Content:
Heat:
- Fundamentals of heat conduction, convection and radiation
- Thermal behaviour of rooms and exterior components
- energy balances
- thermal bridges
- Transient heat conduction in components, mechanism of heat storage
- Thermal insulation materials and systems in comparison
- summer thermal insulation

Moisture:
- Relative humidity
- Water vapour content of air, water vapour partial pressure, dew temperature, diffusion resistance, liquid line
- Moisture transport by diffusion, capillary pressure and flowing air
- Avoidance of surface condensate
- Glaser process

Sound:
- Basic Acoustic Handles
- room acoustics
- Airborne and impact sound insulation
- Acoustic phenomena
- traffic noise
- installation noises

Light:
- Sun and sky, position of the sun, duration of tanning
- Basic lighting terms
- daylight quotient, illuminance distribution in rooms

Intended Learning Outcomes:
After participation in the course, the students are able to understand and calculate building physics phenomena. In addition, simple problems for the building industry in the fields of thermodynamics, moisture protection, sound insulation, lighting technology, room climate, fire protection and urban microclimate can be identified and solved.

Teaching and Learning Methods:
The module consists of a lecture and an accompanying exercise. The contents of the lecture are conveyed in the lecture and through presentations. Students should be encouraged to study the literature and the content of the topics. In the exercises the topics taught in the lecture are deepened to theoretical problems and application problems by means of short repetitions and computational tasks. As part of the exercises, text tasks supplemented with sketches and diagrams are precalculated.

Media:
Documents: scripts, lecture slides, exercises and test sheets.
Powerpoint presentations and calculations (blackboard)

Reading List:
- Gösele, Schüle, Künzel: Schall, Wärme, Feuchte. Bauverlag Wiesbaden, 10. völlig neu bearbeitete Auflage (1997).
- Lutz, Jenisch, Klopfer, Freymuth, Krampf: Lehrbuch der Bauphysik - Schall, Wärme, Feuchte, Licht, Brand - B.G. Teubner, Stuttgart (1997).
- Richter, Fischer, Jenisch, Freymuth, Stohrer, Häupl, Homann: Lehrbuch der Bauphysik - Schall - Wärme - Feuchte - Licht - Brand - Klima - Vieweg+Teubner, Wiesbaden (2008).
- Bauphysik-Kalender 2001. Hrsg. E. Cziesielski. Ernst & Sohn Verlag Berlin (2001).
- Sälzer, E.: Schallschutz im Massivbau. Bauverlag Wiesbaden (1990).
- Zürcher, Ch.: Bauphysik. Verlag der Fachvereine Zürich, (1988).
- Hauser, G., Stiegel, H.: Wärmebrücken-Atlas für den Mauerwerksbau. Bauverlag Wiesbaden, 3. durchgesehene Auflage (1996).
- Hauser, G., Stiegel, H.: Wärmebrücken-Atlas für den Holzbau. Bauverlag Wiesbaden (1992).
- Fischer, Jenisch, Stohrer, Homann, Freymuth, Richter, Häupl: Lehrbuch der Bauphysik Schall Wärme Feuchte Licht Brand Klima Vieweg+Teubner, Wiesbaden (2008).

Responsible for Module:
Klaus Peter Sedlbauer

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

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

Technische Universität München

Module Description

BGU37015: Building Materials - The Basis of Sustainable Construction (Basic Module) [BBNB]

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
Der Leistungsnachweis erfolgt in Form einer 90-minütigen, schriftlichen Klausur. Mithilfe dieser Klausur soll nachgewiesen werden, dass der Studierende ein grundlegendes Wissen zu den Anforderungen an Baustoffe, deren Bedeutung für die Umwelt, und deren Ökobilanzen komprimiert und unter zeitlichem Druck wiedergeben kann. Die Prüfung besteht aus allgemeinen Fragen, in deren Antworten die Studierenden erörtern und diskutieren, stichpunktartig beschreiben und aus vorgegebenen Mehrfachantworten die richtige Antwort ankreuzen müssen. Teils müssen auch kleine Rechenaufgaben gelöst werden.
Die Form der schriftlichen Prüfung ermöglicht somit eine realistische Einschätzung bezüglich der im Rahmen des Moduls erlangten unterschiedlichen Erkenntnisstufen.
Außer einem Taschenrechner sind keine weiteren Hilfsmittel erlaubt.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlagenausbildung in den Gebieten Mathematik, Physik und allgemeine, anorganische Chemie

Content:
¿ Baustoffe und Ressourcenmanagement
¿ Bedeutung der Baustoffe für Infrastruktur und Umweltprojekte
¿ Werkstoffliche Grundlagen der wesentlichen Bau-Werkstoffe:
aus erneuerbaren Ressourcen: Holz
aus nicht-erneuerbaren Ressourcen: Zement und weitere Betonausgangsstoffe, Beton, Stahl, Bitumen und Asphalt,
¿ Umweltwirkungen der Produktion und Anwendung von Baustoffen
¿ Methoden der Bewertung von Umweltwirkungen
¿ Potentiale der Bauwerkstoffe für nachhaltiges Bauen

Intended Learning Outcomes:
Nach der Teilnahme am Modul sind die Studierenden in der Lage, die allgemein technischen und ökologischen Eigenschaften der behandelten Baustoffe darzulegen. Die Studierenden sind fähig, die verursachten Stoffströme durch die Baustoffproduktion und -verarbeitung sowie damit verbundene Umwelteinwirkungen zu klassifizieren. Die Studierenden können geeignete Methoden auswählen, um die Umweltwirkungen von Baustoffen zu charakterisieren und als ergänzende Entscheidungsgrundlage für eine Werkstoffauswahl zu nutzen.

Teaching and Learning Methods:
In der Veranstaltung werden die wesentlichen Lehrinhalte grundsätzlich in Form einer klassischen Vorlesung mit ständiger Unterstützung durch eine PowerPoint-Präsentation vermittelt. Auf das eigenverantwortliche Studium der Fachbegriffe und der grundlegenden Zusammenhänge an Hand der Vorlesungsunterlagen, der Mitschriften und der empfohlenen Literatur wird großer Wert gelegt.
Besondere Detailaspekte oder für das Gesamtverständnis bedeutende Gesichtspunkte werden durch Tafelanschrieb schrittweise hergeleitet und anschaulich erläutert. Dieses Vorgehen ermöglicht den Studenten eine übersichtliche und klar lesbare Darstellung der Inhalte und fördert das konzentrierte Zuhören und somit auch das Verständnis der Studenten, da diese nicht durch ein permanentes Mitschreiben des Tafelanschriebs abgelenkt werden. Teilweise werden Anschauungsmaterialien zur besseren Darstellung und zum besseren Verständnis der Sachverhalte verwendet. Filme zu Versuchen und Verfahren werden integriert. Berechnungsbeispiele werden auf Overheadfolien oder an der Tafel unter Einbeziehung der Studierenden durchgeführt.

Media:
- Powerpointpräsentation
- Tafel- oder Tablet-PC-Anschrieb
- Videos

Reading List:
Die Studierenden erhalten zu Beginn des Semesters ein Literaturverzeichnis mit Leseempfehlungen.

Responsible for Module:
Prof. Dr.-Ing. Detlef Heinz

Courses (Type of course, Weekly hours per semester), Instructor:
LV Baustoffe - Basis Nachhaltigen Bauens (3 SWS)
Prof. Dr.-Ing. Detlef Heinz
Prof. Dr.-Ing. Christoph Gehlen

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

Technische Universität München

Module Description

BGU51018: Building Construction 1 and Sustainable Building basic module

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
individual exams after each semester

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
part 1:Basics of buliding construction part 1, plan representation
part 2: General overview and history of sustainability
Definition and strategies of sustainability
Understanding sustainability
Sustainable development in building and construction at national and international level
Market situation of sustainable construction (economics)
Sustainability in transport and infrastructure
Sustainability in the resource consumption of air, water and soil
Energy and resource scenarios
Sustainability in the planning and design process
Energy production and renewable energies, smart grid
Sustainable supply and disposal, cycles
E-mobility
Materials
Population development and demographic change
Life cycle considerations (planning, implementation, operation/utilization, removal)
Energy and climate optimized planning and building
Sustainable development of residential settlements/quarters

Intended Learning Outcomes:
part 1: At the end of the module students are able to understand and apply the basics of building construction.
part 2: Students who have attended the module courses are able to:
- understand the basic interrelations and subject matter of sustainability on a general level
- outline the backgrounds, developments and implementations of the principles of sustainability
- understand the concept of sustainability in integrative terms and implement the classic dimensions of sustainability, i.e. ecology, economy, social, cultural and societal aspects, as well as design-related, technical, process-oriented and site-specific factors

- apply basic knowledge of energy concepts, building materials, the analysis of process flows (construction, operation and demolition)"

Teaching and Learning Methods:
Lectures and presentations give insight in basic theoretical concepts. In in-class exercises, students learn to apply the theory on practical case studies.

Media:
presentation, black board, script

Reading List:
Frick, Knöll: Baukonstruktionslehre in 2 Bänden, Teubner-Verlag, Stuttgart, 2001 (Baukonstruktions-Bibel);
Verschiedene Autoren: Baukonstruktions-Atlanten des Instituts für Internationale Architektur-Dokumentation, München, im Birkhäuser-Verlag, Basel, Boston, Berlin bzw. Rudolf-Müller-Verlag, Düsseldorf;
Neufert: Bauentwurfslehre, Vieweg-Verlag, Braunschweig, 1992 ;
Baustoffatlas, Birkhäuser Verlag 2005 Bundesministerium für Wirtschaft und Technologie:
Energiekonzept der Bundesregierung für eine umweltschonende, zuverlässige und bezahlbare Energieversorgung, 09/2010
Bundesministerium für Wirtschaft und Technologie:
Energie in Deutschland. Trends und Hintergründe zur Energieversorgung, 08/2010.
http://www.nachhaltige-quartiere.ch
http://www.novatlantis.ch/2000watt.html
Stadt Bauwelt - Stadt & Energie, Jg. 102. Jahrgang, H. 189 12.11
Hrsg. Bayerisches Staatsministerium für Umwelt und Gesundheit, Bayerisches Staatsministerium für Wirtschaft, Verkehr, Infrastruktur und Technologie, Oberste Baubehörde im Bayerischen Staatsministerium des Innern:
Leitfaden Energienutzungsplan Teil 1. München, 2010
Hrsg. Bundesministerium für Wirtschaft und Technologie: Energie in Deutschland. Trends und Hintergründe zur Energieversorgung. Berlin, 2010
Hrsg. Burdett, Ricky: The endless city. The urban age project by the London School of Economics and Deutsche Bank's Alfred Herrhausen Society. London, 2007
Erhorn-Kluttig, Heike et al.: Energetische Quartiersplanung. Methoden Technologien Praxisbeispiele. Stuttgart, 2011
Hrsg. Le Monde diplomatique: Atlas der Globalisierung. Sehen und verstehen, was die Welt bewegt. Berlin, 2009
Santamouris, Mat (Hg.) (2006): Environmental design of urban buildings. An integrated approach. London: Earthscan.
Hegger, Manfred; Fuchs, Matthias; Stark, Thomas; Zeumer, Martin: Energie Atlas - Nachhaltige Architektur Institut für Internationale Architekur-Dokumentation, München 2007
Keller, Bruno; Rutz, Stephan: Pinpoint - Fakten der Bauphysik zu nachhaltigem BauenHochschulverlag AG an der ETH Zürich 2007
Lenz, Bernhard; Schreiber, Jürgen; Stark, Thomas:Nachhaltige GebäudetechnikDETAIL Green Books, München 2010
Ewing, Moore, Goldfinger, Oursler, Reed, Wackernagel, 2010The Ecological Footprint Atlas 2010. Oakland: Global Footprint Network.
Wackernagel, Rees, 1997Unser ökologischer Fußabdruck. Birkhäuser Verlag
Braungart, M., McDonough, W., Einfach intelligent produzieren. Cradle to Cradle: Die Natur zeigt wie wir Dinge besser machen können. Berliner Taschenbuchverlag, 2008
Lebenszyklusanalyse in der Gebäudeplanung, Detail green books, 2009
W. Klöpffer, B. Grahl: Ökobilanz (LCA) Ein Leitfaden für Ausbildung und Beruf. Weinheim, 2009
Annie Leonard: The Story of Stuff. Wie wir unsere Erde zumüllen. Berlin, 2010
www.storyofstuff.com
Detail Zeitschrift für Architektur. 50. Serie 2010/12 Architektur + Recycling
Arjen Y. Hoekstra und Ashok K. Chapaign: Globalization of Water (Sharing the Planets Freshwater Resources), Blackwell Publishing, 2009
Water in a Changing World: The United Nations Water Development Report 3, UNESCO Publishing, 2009

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

Courses (Type of course, Weekly hours per semester), Instructor:
Building Construction 1 (lecture with integrated exercises, 2 SWS)
Winter S [L], Winter S, Bodemer E, Krechel M, Henke K

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

Electives

Technische Universität München

Module Description

BGU37015: Building Materials - The Basis of Sustainable Construction (Basic Module) [BBNB]

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
Der Leistungsnachweis erfolgt in Form einer 90-minütigen, schriftlichen Klausur. Mithilfe dieser Klausur soll nachgewiesen werden, dass der Studierende ein grundlegendes Wissen zu den Anforderungen an Baustoffe, deren Bedeutung für die Umwelt, und deren Ökobilanzen komprimiert und unter zeitlichem Druck wiedergeben kann. Die Prüfung besteht aus allgemeinen Fragen, in deren Antworten die Studierenden erörtern und diskutieren, stichpunktartig beschreiben und aus vorgegebenen Mehrfachantworten die richtige Antwort ankreuzen müssen. Teils müssen auch kleine Rechenaufgaben gelöst werden.
Die Form der schriftlichen Prüfung ermöglicht somit eine realistische Einschätzung bezüglich der im Rahmen des Moduls erlangten unterschiedlichen Erkenntnisstufen.
Außer einem Taschenrechner sind keine weiteren Hilfsmittel erlaubt.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlagenausbildung in den Gebieten Mathematik, Physik und allgemeine, anorganische Chemie

Content:
¿ Baustoffe und Ressourcenmanagement
¿ Bedeutung der Baustoffe für Infrastruktur und Umweltprojekte
¿ Werkstoffliche Grundlagen der wesentlichen Bau-Werkstoffe:
aus erneuerbaren Ressourcen: Holz
aus nicht-erneuerbaren Ressourcen: Zement und weitere Betonausgangsstoffe, Beton, Stahl, Bitumen und Asphalt,
¿ Umweltwirkungen der Produktion und Anwendung von Baustoffen
¿ Methoden der Bewertung von Umweltwirkungen
¿ Potentiale der Bauwerkstoffe für nachhaltiges Bauen

Intended Learning Outcomes:
Nach der Teilnahme am Modul sind die Studierenden in der Lage, die allgemein technischen und ökologischen Eigenschaften der behandelten Baustoffe darzulegen. Die Studierenden sind fähig, die verursachten Stoffströme durch die Baustoffproduktion und -verarbeitung sowie damit verbundene Umwelteinwirkungen zu klassifizieren. Die Studierenden können geeignete Methoden auswählen, um die Umweltwirkungen von Baustoffen zu charakterisieren und als ergänzende Entscheidungsgrundlage für eine Werkstoffauswahl zu nutzen.

Teaching and Learning Methods:
In der Veranstaltung werden die wesentlichen Lehrinhalte grundsätzlich in Form einer klassischen Vorlesung mit ständiger Unterstützung durch eine PowerPoint-Präsentation vermittelt. Auf das eigenverantwortliche Studium der Fachbegriffe und der grundlegenden Zusammenhänge an Hand der Vorlesungsunterlagen, der Mitschriften und der empfohlenen Literatur wird großer Wert gelegt.
Besondere Detailaspekte oder für das Gesamtverständnis bedeutende Gesichtspunkte werden durch Tafelanschrieb schrittweise hergeleitet und anschaulich erläutert. Dieses Vorgehen ermöglicht den Studenten eine übersichtliche und klar lesbare Darstellung der Inhalte und fördert das konzentrierte Zuhören und somit auch das Verständnis der Studenten, da diese nicht durch ein permanentes Mitschreiben des Tafelanschriebs abgelenkt werden. Teilweise werden Anschauungsmaterialien zur besseren Darstellung und zum besseren Verständnis der Sachverhalte verwendet. Filme zu Versuchen und Verfahren werden integriert. Berechnungsbeispiele werden auf Overheadfolien oder an der Tafel unter Einbeziehung der Studierenden durchgeführt.

Media:
- Powerpointpräsentation
- Tafel- oder Tablet-PC-Anschrieb
- Videos

Reading List:
Die Studierenden erhalten zu Beginn des Semesters ein Literaturverzeichnis mit Leseempfehlungen.

Responsible for Module:
Prof. Dr.-Ing. Detlef Heinz

Courses (Type of course, Weekly hours per semester), Instructor:
LV Baustoffe - Basis Nachhaltigen Bauens (3 SWS)
Prof. Dr.-Ing. Detlef Heinz
Prof. Dr.-Ing. Christoph Gehlen

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

Technische Universität München

Module Description

BGU38016: Sanitary Engineering and Water Quality Basic Module

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The exam consists of general questions and calculations.
In the written exam students demonstrate by answering questions the theoretical knowledge of water supoply, sewer systems, wastewater and sewage sludge treatment. By doing calculations they show that they are able to create calculation tasks in this topics.
The answers requires wording but also multiple choice tests are involved. Focus are calculations.
For the first part ¿general questions¿ (duration 30 min) tools are not allowed, for the second part ¿calculations¿ (duration 90 min) the use of a calculator and all powerpoint slides form the lecture are allowed in the written exam

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in chemistry, biology and physics is util

Content:
The lecture deals with parameters for the evaluation of water and wastewater samples. Water supply basics (demand, consumption, hauling, storage, distribution) are covered. Moreover principles of wastewater treatment are discussed (bioprocess techniques, mechanical and biological treatment, design of activated sludge systems). Also slude dewatering and treatment are in the focus of the lecture.

Intended Learning Outcomes:
The students will be able to design wastewater treatment as well as water supply units. Based on the wastewater composition they will be able to determine necessary treatment processes.

Teaching and Learning Methods:
Lecture with Powerpoint and Board. Deepening of the knowledge with exercises.

Media:
Board, Beamer, Script

Reading List:
Gujer, Willi ((2007): Siedlungswasserwirtschaft, Springer Verlag Berlin

Responsible for Module:
Brigitte Helmreich (b.helmreich@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Urban Water Systems Engineering Base Module (lecture with integrated exercises, 4 SWS)
Helmreich B [L], Helmreich B, Koch K

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

Technische Universität München

Module Description

BGU38020: System Design - Urban Water Systems Engineering

Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Bachelor	German	one semester	summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
5	150	120	30

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

Description of Examination Method:
The exam consists of a project report and its presentation (20 minutes) in the field of municipal water or wastewater treatment.
The project work shall be carried out in different phases (Initiation, problem definition, role distribution, idea creation, criteria development, decision making, execution, presentation, written elaboration) leading to the conceptual design of a water or wastewater treatment facility. The project work is a group work with a clear assignment (group of two students) of specific treatment processes as well as the hydraulic design. The group work shall prove the team work skills of the students. The project shall assess, if the students have understood and are able to apply theoretical knowledge in mechanical and biological treatment methods and to create a process scheme for a water/wastewater treatment plant under given specific boundary conditions. Supervision takes place during the presence dates by tutors. Through the presentation the students prove that they can communicate their project to an expert audience and can defend system and method choices and the dimensioning of treatment facilities. The presentation accounts for 20 % of the grade.

Repeat Examination:

(Recommended) Prerequisites:
Introduction to water supply and wastewater engineering (or equivalent)

Content:
1.Design principles of water treatment and wastewater treatment facilities
2.Key lessons for the preparation of technical reports
3.Regulatory and technical requirements
4.Case study drinking water supply
5.Case study wastewater treatment

Intended Learning Outcomes:
By completion of this module students are able to know, understand and apply different treatment processes in the field of municipal water or wastewater treatment. They can evaluate combinations of treatment methods and apply them on a given project with known boundary conditions for which they are able to create a basic operational design. They can understand, evaluate as well as compose own technical reports for water/wastewater treatment projects. Through the presentation they show that they are able to defend their system decisions in front of an expert audience and support their dimensioning of the facilities through comprehensive arguments.

Teaching and Learning Methods:
Lecture for the presentation of the theoretical abckground; Practical exercises for a better understand-ing of real processes; Preparation of a technical report (team assignments), will count as final exam with a subsequent presentation to focus on the communication skills.

Media:
Powerpoint presentations; Exercises in class and as voluntary homework via Moodle

Reading List:
Literature reference list will be posted at the beginning of the semester.

Responsible for Module:
Prof. Dr.-Ing. Jörg Drewes

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

Prof. Dr.-Ing. Jörg Drewes

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

Technische Universität München

Module Description

BGU40027: Spatial Planning and Land Tenure Basic Module

Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Bachelor	German/English	one semester	winter semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
5	120	60	60

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

Description of Examination Method:
Die Modulleistung wird in einer schriftlichen Prüfung in Form einer Klausur erbracht.
Ohne Hilfsmittel sollen die Studierenden Regelungen und Vorgehensweisen der Raumplanung und Raumentwicklung wiedergeben und in eigenen Formulierungen nachweisen, dass sie die Komplexität räumlicher Planung verstanden haben und Zusammenhänge erläutern können. In Fragen zu Beispielfällen soll das erlernte Wissen praktisch angewandt werden können. Die Studierenden sollen nachweisen, dass sie die Bedeutung des Eigentumsbegriffs verstanden haben, Grundbegriffe aus dem Bereich der Bodenpolitik in eigenen Formulierungen erläutern können und an praktischen Beispiele im Zusammenhang von Bodenpolitik, Bodenrecht und Bodenordnung anwenden können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
keine

Content:
Grundzüge der Räumlichen Planung (deutsch):
A) Grundlagen
-- Anlass, Zweck und Ziel räumlicher Planung
-- Definition von räumlicher Planung, Raumordnung und Raumentwicklung
B) Raumordnung: Strukturen, Abläufe und
- Instrumente in Deutschland und Europa
-- Planungsebenen, Planungsprinzipien, Gesetzliche Grundlagen
-- Europäische Ebene und Bundesraumordnung
-- Die Landesplanung - Aufgaben und Instrumente, das Raumordnungsverfahren
-- Die Regionalplanung - Inhalte und Aufgaben am Beispiel der Region München
-- Die kommunale Bauleitplanung ¿ Aufgaben und Vorgehensweisen am Beispiel der Stadt München
C) Raumentwicklung: Informelle Planung und Beteiligung
-- Beteiligung in Planungsprozessen ¿ Anlass, Ziel und Vorgehensweise
-- Formelle und informelle Planung ¿ Ziele, Vorgehensweisen, Wechselwirkungen
-- Informelle Planung in der Praxis: Beispiele (Planungsbüro und Kommune)

Bodenrecht und Bodenordnung (englisch):
In der Vorlesung erfolgt eine detaillierte Einführung und Auseinandersetzung in den Bereichen Bodenpolitik, Bodenrecht und Bodenordnung mit folgenden Themen:
-- Begriff und Bedeutung des Bodens
-- Entwicklungslinien des Eigentums an Grund und Boden

-- Eigentumsrecht
-- Inhalt und Schranken des Eigentums
-- Grundlagen der Enteignung
-- Definition Bodenrecht
-- Grundbuch- und Grundstücksrecht

Intended Learning Outcomes:
Nach der Teilnahme an der Modulveranstaltung kennen die Studierenden gesetzliche Grundlagen, Planungsprinzipien und Instrumente räumlicher Planung. Sie sind in der Lage, Planungsabläufe in Raumordnung und Raumentwicklung zu beschreiben, komplexe Planungsprozesse zu verstehen und fachübergreifende Zusammenhänge räumlicher Planungen zu diskutieren. Sie können Planungsbeispiele in den räumlichen und fachlichen Kontext einordnen und theoretische Erkenntnisse auf die Praxis anwenden. Sie verstehen die umfassende Bedeutung des Eigentumsbegriffs und sind in der Lage, Grundbegriffe aus dem Bereich der Bodenpolitik sowie praktische Beispiele im Zusammenhang von Bodenpolitik, Bodenrecht und Bodenordnung anzuwenden.

Teaching and Learning Methods:
Lehrformat: Vorlesung
Methoden Räumliche Planung: interaktiver Vortrag mit Präsentation zur Vermittlung von Wissen, ergänzt durch Kleingruppenarbeit zur Vertiefung des Gehörten und Formulierung von offenen Fragen
Veranschaulichung der Theorie durch Beispiele aus der Praxis vorgetragen durch Gastreferenten
Methoden Bodenrecht und Bodenordnung: interaktiver Vortrag mit Präsentation zur Vermittlung von Wissen
Die Lehrmethoden sind auf die Lernaktivitäten Materialrecherche, Studium von Literatur und Auswendiglernen ausgerichtet.

Media:
- Power Point Präsentation
- Vorlesungsskript

Reading List:

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

Courses (Type of course, Weekly hours per semester), Instructor:
Basic Elements of Spatial Planning (lecture, 2 SWS)
de Vries W [L], Bendzko T

Land Tenure and Land Readjustment (lecture, 2 SWS)
de Vries W [L], de Vries W

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

Technische Universität München

Module Description
BGU41018T2: Applied Hydromechanics

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
By successfull completion of four online lessons and associated lab sessions the students show, that they are able to explain fundamental concepts and influencing factors of the method learned and to apply those on practical examples. This will be counted as a ungraded course achievment.
A 60 minutes written exam at the end of the semester tests if the students are able to compute the flow over weirs, out of basins and reservoirs and under sluice gates as well as unsteady flow problems and one-dimensional water levels. There they have to answer comprehensive questions and small calculation problems concerning the topics of the course. In addition a part of an example river containing several installations (i.e. weir, sluice gate, narrowing) and sections (i.ex. rectangular cross section, smooth/ rough surface) has to be analysed in order to determine the trend of the water level for this part. All aids are allowed.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Modul BV000013 "Hydromechanik".
Simple programming knowledge to programm a programmable calculator.

Content:
- Flow from openings and under sluice gates
- Weir overflows
-steady uniform channel hydraulics
-steady non-uniform channel hydraulics
- differential equation of the water level
- St. Venant-equation
- method of Böß
-1D calculation and graphical description of water level trends
- Unsteady phenomena in open channel flows (upsurge and downsurge)

Intended Learning Outcomes:
Upon completion of this class students are able to:
- discuss the differential equation of the water level for free surface flows
- describe the St.-Venant equation for free surface flows
- determine the outflow process and outflow time from openings under consideration of variable surfaces, cross sections and openings

- predict flow rates over weir tops and under sluice gates
- determine water level trends of channel flows
- calculate unsteady phenomena in open channels caused by regulation processes

Teaching and Learning Methods:
The course is divided into three consecutive parts: a lecture, an eLearning course and a lab exercise in groups. In the lecture slides are used to explain and discuss the contents with the students. During the independent learning phase the students reinforce the contents using online lessons. These online lessons contain practical questions and examples to prepare the experiments which will be performed in the lab afterwards. There the students conduct illustrating experiments in small groups (appr. 6 students). By this means the opportunity to independently deeply understand the contents is given to the students. The experimental part in the lab is supported by a scriptum.

Media:
lecture script, lab exercise script, black/white board, slides, experiments in the laboratory, eLearning materials

Reading List:
- lecture script
- Franke, P. (1974), Hydraulik für Bauingenieure, Sammlung de Gruyter, Berlin
- Bollrich, G. (2007), Technische Hydromechanik 1, Verlag Bauwesen, Berlin

Responsible for Module:
Michael Manhart

Courses (Type of course, Weekly hours per semester), Instructor:
Angewandte Hydromechanik
Michael Manhart, Claudia Strobl

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

Technische Universität München

Module Description

BGU51018: Building Construction 1 and Sustainable Building basic module

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
individual exams after each semester

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
part 1:Basics of buliding construction part 1, plan representation
part 2: General overview and history of sustainability
Definition and strategies of sustainability
Understanding sustainability
Sustainable development in building and construction at national and international level
Market situation of sustainable construction (economics)
Sustainability in transport and infrastructure
Sustainability in the resource consumption of air, water and soil
Energy and resource scenarios
Sustainability in the planning and design process
Energy production and renewable energies, smart grid
Sustainable supply and disposal, cycles
E-mobility
Materials
Population development and demographic change
Life cycle considerations (planning, implementation, operation/utilization, removal)
Energy and climate optimized planning and building
Sustainable development of residential settlements/quarters

Intended Learning Outcomes:
part 1: At the end of the module students are able to understand and apply the basics of building construction.
part 2: Students who have attended the module courses are able to:
- understand the basic interrelations and subject matter of sustainability on a general level
- outline the backgrounds, developments and implementations of the principles of sustainability
- understand the concept of sustainability in integrative terms and implement the classic dimensions of sustainability, i.e. ecology, economy, social, cultural and societal aspects, as well as design-related, technical, process-oriented and site-specific factors

- apply basic knowledge of energy concepts, building materials, the analysis of process flows (construction, operation and demolition)"

Teaching and Learning Methods:
Lectures and presentations give insight in basic theoretical concepts. In in-class exercises, students learn to apply the theory on practical case studies.

Media:
presentation, black board, script

Reading List:
Frick, Knöll: Baukonstruktionslehre in 2 Bänden, Teubner-Verlag, Stuttgart, 2001 (Baukonstruktions-Bibel);
Verschiedene Autoren: Baukonstruktions-Atlanten des Instituts für Internationale Architektur-Dokumentation, München, im Birkhäuser-Verlag, Basel, Boston, Berlin bzw. Rudolf-Müller-Verlag, Düsseldorf;
Neufert: Bauentwurfslehre, Vieweg-Verlag, Braunschweig, 1992 ;
Baustoffatlas, Birkhäuser Verlag 2005 Bundesministerium für Wirtschaft und Technologie:
Energiekonzept der Bundesregierung für eine umweltschonende, zuverlässige und bezahlbare Energieversorgung, 09/2010
Bundesministerium für Wirtschaft und Technologie:
Energie in Deutschland. Trends und Hintergründe zur Energieversorgung, 08/2010.
http://www.nachhaltige-quartiere.ch
http://www.novatlantis.ch/2000watt.html
Stadt Bauwelt - Stadt & Energie, Jg. 102. Jahrgang, H. 189 12.11
Hrsg. Bayerisches Staatsministerium für Umwelt und Gesundheit, Bayerisches Staatsministerium für Wirtschaft, Verkehr, Infrastruktur und Technologie, Oberste Baubehörde im Bayerischen Staatsministerium des Innern: Leitfaden Energienutzungsplan Teil 1. München, 2010
Hrsg. Bundesministerium für Wirtschaft und Technologie: Energie in Deutschland. Trends und Hintergründe zur Energieversorgung. Berlin, 2010
Hrsg. Burdett, Ricky: The endless city. The urban age project by the London School of Economics and Deutsche Bank's Alfred Herrhausen Society. London, 2007
Erhorn-Kluttig, Heike et al.: Energetische Quartiersplanung. Methoden Technologien Praxisbeispiele. Stuttgart, 2011
Hrsg. Le Monde diplomatique: Atlas der Globalisierung. Sehen und verstehen, was die Welt bewegt. Berlin, 2009
Santamouris, Mat (Hg.) (2006): Environmental design of urban buildings. An integrated approach. London: Earthscan.
Hegger, Manfred; Fuchs, Matthias; Stark, Thomas; Zeumer, Martin: Energie Atlas - Nachhaltige Architektur Institut für Internationale Architekur-Dokumentation, München 2007
Keller, Bruno; Rutz, Stephan: Pinpoint - Fakten der Bauphysik zu nachhaltigem BauenHochschulverlag AG an der ETH Zürich 2007
Lenz, Bernhard; Schreiber, Jürgen; Stark, Thomas:Nachhaltige GebäudetechnikDETAIL Green Books, München 2010
Ewing, Moore, Goldfinger, Oursler, Reed, Wackernagel, 2010The Ecological Footprint Atlas 2010. Oakland: Global Footprint Network.
Wackernagel, Rees, 1997Unser ökologischer Fußabdruck. Birkhäuser Verlag
Braungart, M., McDonough, W., Einfach intelligent produzieren. Cradle to Cradle: Die Natur zeigt wie wir Dinge besser machen können. Berliner Taschenbuchverlag, 2008
Lebenszyklusanalyse in der Gebäudeplanung, Detail green books, 2009
W. Klöpffer, B. Grahl: Ökobilanz (LCA) Ein Leitfaden für Ausbildung und Beruf. Weinheim, 2009
Annie Leonard: The Story of Stuff. Wie wir unsere Erde zumüllen. Berlin, 2010
www.storyofstuff.com
Detail Zeitschrift für Architektur. 50. Serie 2010/12 Architektur + Recycling
Arjen Y. Hoekstra und Ashok K. Chapaign: Globalization of Water (Sharing the Planets Freshwater Resources), Blackwell Publishing, 2009
Water in a Changing World: The United Nations Water Development Report 3, UNESCO Publishing, 2009

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

Courses (Type of course, Weekly hours per semester), Instructor:
Building Construction 1 (lecture with integrated exercises, 2 SWS)
Winter S [L], Winter S, Bodemer E, Krechel M, Henke K

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

Technische Universität München

Module Description

BGU54006: Hydrology Basic Module

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
In der 90-minütigen schriftlichen Klausur wird nachgewiesen, inwieweit die Studierenden die theoretischen Grundlagen des Wasserkreislaufs, der quantitativen Hydrologie, der Extremwertstatistik, des Hochwasserrisikomanagements sowie der Niederschlag-Abfluss-Modellierung verstehen und unter Zeitdruck wiedergeben können.
Die Antworten beziehen sich zum einen auf theoretische Fragen, basierend auf den Lernergebnissen des Moduls, und zum anderen auf Rechenaufgaben zur Anwendung anerkannter hydrologischer und statistischer Methoden sowie geeigneter Bemessungsverfahren. Die Studierenden sollen in der Lage sein, das Problem zu erkennen und anschließend zu lösen.
In der Klausur sind keine Hilfsmittel zugelassen.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundlegende Kenntnisse in Höherer Mathematik, Statistik und Physik
z.B. Module des Bachelorstudiengangs Umweltingenieurwesen:
Höhere Mathematik 1 und Höhere Mathematik 2, angewandte Mathematik, Meteorologie

Content:
Theorie und Berechnungsmethoden zu den verschiedenen Prozessen des Wasserkreislaufs:
- Niederschlag: Niederschlagsbildung, räumliche und zeitliche Variabilität, Niederschlagsmessung, Gebietsniederschlag
- Verdunstung: Arten der Verdunstung, Messung der Verdunstung, Berechnungsmethoden
- Infiltration: Einflussfaktoren, charakteristische Kennwerte, Saugspannungs-Sättigungs-Beziehung, Messmethoden
- Wasserfluss in der ungesättigten Bodenzone (Richards-Gleichung)
- Schneehydrologie: Schneeakkumulation, -metamorphose und -ablation
- Grundwasser: Vorkommen, Grundwasserneubildung, Grundwasserströmung

Beschreibung und Quantifizierung der Abflussprozesse:
- Abflussbildung: Effektivniederschlag, Gesamtabflussbeiwert, zeitlich verteilter Abflussbeiwert
- Abflusskonzentration: Konzentrationszeit, Isochronenmodell, Einzellinearspeicher, lineare Speicherkaskade
- Gerinneabfluss: Abflusshysterese, Muskingum-Verfahren, Kalinin-Miljukov-Verfahren

Grundlagen der hydrologischen Statistik:
- Wasserwirtschaftliche Kennwerte und gewässerkundliche Hauptzahlen
- Datengrundlage, Überprüfung der Stichprobe
- Anwendung von Verteilungsfunktionen
- Statistische Testverfahren

Gesetzliche Grundlagen
- Bedeutung der EG Wasserrahmenrichtlinie (EG-WRRL)
- Bedeutung der EG Hochwasserrisikomanagement Richtlinie (EG-HWRM-RL)
Hochwasserschutz und Hochwasserrisikomanagement:
- Definitionen und Begriffe
- Bemessung und Berechnung von Hochwasserrückhaltebecken
Hydrologische Modellierung:
- Arten, Zielstellung, Datengrundlage und Aufbau unterschiedlicher hydrologischer Modelle
- Anwendung eines einfachen konzeptionellen hydrologischen Modells
- Vorstellung eines komplexen physikalisch basierten hydrologischen Modells

Intended Learning Outcomes:
Nach der Teilnahme des Grundmoduls Hydrologie sind die Studierenden in der Lage,
- die theoretischen Grundlagen, Prozesse und Zusammenhänge des Wasserkreislaufs, des Niederschlag-Abfluss-Prozesses, der Schnee- und Bodenhydrologie sowie der Hochwasserentstehung zu verstehen.
- die Zielstellung, theoretischen Grundlagen und Methoden der hydrologischen Statistik zu verstehen.
- Berechnungsverfahren zur Quantifizierung der Wasserhaushalts- und Abflusskomponenten, zur Ermittlung extremer Abflüsse sowie zur Bemessung von Hochwasserschutzmaßnahmen anzuwenden.
- ein einfaches hydrologisches Modell anzuwenden und mit ihm hinsichtlich seiner Parametrisierung zu experimentieren.

Teaching and Learning Methods:
Das Modul wird als Vorlesung abgehalten, welche für jeden Themenabschnitt aus einem Theorieteil zur Wissensvermittlung durch Frontalunterricht und Diskussion besteht, dem ein Übungsteil zur beispielhaften und praxisorientierten Anwendung der theoretischen Grundlagen folgt.
Die Inhalte der Vorlesung werden im Vortrag und durch Präsentationen vermittelt. Hierbei werden die Studierenden zum Studium der empfohlenen Literatur und der inhaltlichen Auseinandersetzung mit den Themen angeregt.
In den Übungen werden themenbezogene Probleme gelöst und konkrete Fragestellungen beantwortet.

Media:
- Skriptum
- Übungsblätter
- Powerpoint-Präsentation
- Tafelanschrieb

Reading List:
- Dyck/Peschke 1995 : Grundlagen der Hydrologie ISBN 3-345-00586-7
- Maniak 1997: Hydrologie und Wasserwirtschaft ISBN 3-540-63292-1
- Baumgartner/Liebscher 1996: Allgemeine Hydrologie ISBN 3-443-30002-2
- Plate 1993: Statistik und angewandte Wahrscheinlichkeitslehre für Bauingenieure ISBN 978-3-433-01073-0

Responsible for Module:
Dr.-Ing. Wolfgang Rieger (wolfgang.rieger@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Hydrology Basic Module (lecture, 4 SWS)
Disse M [L], Disse M, Teixeira Leandro J

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

Technische Universität München

Module Description

BGU54018: Water Quality [WQ]

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
At the end of the module, students participate in a written exam of 60 minutes duration. The exam will focus on the transport and transformation processes described during the course and on the measurement technologies used in the monitoring of water quality, according to the water framework directive. The exam will verify that the student understand the principles of reactive transport in the environment. Furthermore, it will verify that the students understand basic concepts of environmental chemistry and physics and that the students are able to apply those concepts for the solution of problems within a given period of time. The exam will consist of open questions, multiple choice questions and mainly exercises which will require short computations. No auxiliary material is allowed during the exam.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in hydrology, hydrogeology and environmental chemistry

Content:
- General introduction on fate and transport of contaminants in the environment
- Physical principles behind the measurement of chemical quantities and their application in water quality
- Planning of monitoring quality projects
- Introduction to environmental modeling
- The Water framework directive in Europe and Bavaria

Intended Learning Outcomes:
At the end of the module, students are able:
- to understand the basic processes controlling fate and transport of contaminants in the environment
- to understand the functioning of measurement devices used in laboratory and in the field.
- to develop monitoring quality plans
- to develop simple water quality models
- to understand the current legislation related to water quality

The main objective of the lectures is to enable students to understand the physical and chemical processes controlling water quality, to understand the legislation and the working principles of the instruments used to monitor water quality and to develop water quality monitoring plans.

Teaching and Learning Methods:
Lectures (Power-Point-Presentation, blackboard), exercises (individual).
The teaching philosophy behind this module is based on the evidence that different study goals will be achieved using different approaches. The theoretical lectures¿ contents are presented by the lecturer using both the blackboard and digital slides. The students will get familiar with the subject solving independently relevant practical problems

Media:
Power-Point-Presentation
Blackboard

Reading List:
- Schoor J.L. (1996), Enviromental Modeling fate and transport of pollutants in water, air and soil
- The EU Water Framework Directive (http://ec.europa.eu/environment/water/water-framework/index_en.html)

Responsible for Module:
Dr. Gabriele Chiogna (gabriele.chiogna@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Water quality (lecture, 2 SWS)
Chiogna G [L], Chiogna G, Teixeira Leandro J

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

Technische Universität München

Module Description

BGU54020: Conceptual Hydrological Modelling [CHM]

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
Die Prüfungsleistung besteht aus einer 60-minütigen schriftlichen Prüfung. Die Prüfungsfragen beinhalten den gesamten Vorlesungsstoff und bestehen aus theoretischen Fragen und Rechenaufgaben. Ein nicht-programmierbarer Taschenrechner ist zugelassen, weitere Hilfsmittel sind nicht erlaubt.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse in Hydrologie
(z.B. Hydrologie Grundmodul)

Content:
¿ Einführung: Überblick über die wichtigsten hydrologischen Prozesse und die wichtigsten physikalischen und empirischen Konzepte
¿ Definition und Komponenten eines hydrologischen Modells
¿ Einsatzgebiete und Nutzen von hydrologischen Modellen
¿ Modelltypen, Klassifizierung und Einordnung
¿ Einordnung und Aufbau eines einfachen Modells in MS-Excel (Computerübung)
¿ Anwendungsbeispiel des MS-Excel-Modells (Computerübung, Hausübung)
¿ Einordnung und Aufbau eines HEC-HMS-Modells (Computerübung)
¿ Anwendungsbeispiel des HEC-HMS-Modells (Computerübung, Hausübung)
¿ Einordnung und Aufbau eines HBV-Lite-Modells (Computerübung)
¿ Anwendungsbeispiel des HBV-Lite-Modells (Computerübung, Hausübung)
¿ Zusammenfassung und Vergleich der Modellergebnisse

Intended Learning Outcomes:
Die Studierenden kennen nach Abschluss des Moduls die Bedeutung hydrologischer Modelle, deren Einsatzgebiete und grundlegende Struktur. Sie sind nach Abschluss der Lehrveranstaltung in der Lage, hydrologische Prozesse in konzeptionellen hydrologischen Modellen nachzuvollziehen, computertechnische Konzepte und Rechenwege innerhalb der Modelle zu verstehen und die besprochenen Modelle (ein einfaches Modell in MS Excel, HEC-HMS und HBV Lite) anzuwenden. Weiterhin sind sie dazu in der Lage, den Kalibrierungs- und Validierungsprozess sowie die damit verbundenen Probleme zu verstehen und einzuschätzen. Sie können die Anwendbarkeit sowie Vor- und Nachteile von konzeptionellen hydrologischen Modellen analysieren, vergleichen und bewerten.

Teaching and Learning Methods:
Vorlesung mit integrierten Übungen

Media:
Powerpointpräsentation, Tafelanschrieb, Übungsbeispiele, Computerübungen, etc.

Reading List:
K. Eckardt (2014): Hydrologische Modellierung - Ein Einstieg mithilfe von Excel. Springer, Berlin Heidelberg

HEC, U.S. Army Corps of Engineers Hydrologic Engineering Center (2013): HEC-GeoHMS User's Manual

HEC, U.S. Army Corps of Engineers Hydrologic Engineering Center (2000): HEC-HMS Technical Reference Manual

Modellbeschreibung HBV-Lite

Responsible for Module:
Prof. Dr.-Ing. Markus Disse
markus.disse@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
LV0000003644: Konzeptionelle hydrologische Modellierung
Johannes Mitterer, M.Sc.
johannes.mitterer@tum.de

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

Technische Universität München

Module Description

BGU54022: Statistics in Hydrology

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
Innerhalb einer Projektarbeit zeigen die Studierenden, dass Sie in der Lage sind, an Hand gegebenem Datensatz und vorgegebener Problemstellung aus dem Bereich der Hydrologie geeignete Methoden zur statistischen Analyse auszuwählen und diese unter Verwendung einer geeigneten Softwareumgebung anzuwenden. Die Dokumentation der Projektarbeit erfolgt in Form eines Berichtes. Innerhalb einer anschließenden Präsentation des Berichtes (15 min. ¿ 20 min.) zeigen die Studierenden, dass Sie in der Lage sind, die verwendeten Methoden hinsichtlich ihrer Vor- und Nachteile zu analysieren und bewerten.
Die Projektarbeit (inkl. Bericht und Präsentation) kann in Kleingruppen (bis zu 3 Studierende) angefertigt werden, wobei die jeweilige Einzelleistung kenntlich zu machen ist.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Hydrology Basic Module

Content:
¿ Einführung: Begriffe, Definitionen und Ziele in der hydrologischen Statistik, Einführung in die zu nutzende Software
¿ Datenerhebung/Datenprüfung: Graphische Darstellung, mathematische Beschreibung, Methoden zur Datenprüfung (z.B. Homogenitätsanalyse, Trendanalyse und Sprunganalyse)
¿ Korrelation und Regressionsanalyse
¿ Wahrscheinlichkeit und Verteilungsfunktionen: Stichprobe und Grundgesamtheit, Verteilungsfunktionen in der Hydrologie, Anpassungsmethoden
¿ Schließende Statistik: Signifikanz, Testverfahren und Konfidenzintervalle
¿ Hydrologische Zeitreihen: Testverfahren, Eigenschaften von Zeitreihen, Generierung von Zeitreihen

Intended Learning Outcomes:
Die Studierenden kennen nach Abschluss des Moduls die Bedeutung statistischer Methoden in der Hydrologie sowie deren Ziele und Einsatzgebiete. Sie sind nach Abschluss der Lehrveranstaltungen in der Lage, statistische Methoden sowohl in der theoretischen Anwendung als auch in geeigneter computerunterstützter Softwareumgebung nachzuvollziehen. Sie können weiterhin gegebene Problemstellungen hinsichtlich der anzuwendenden statistischen Methode analysieren und das geeignete statistische Verfahren unter Verwendung der entsprechenden Software zur Lösung der gegebenen Problemstellung anwenden. Sie können die Anwendbarkeit sowie Vor- und Nachteile von unterschiedlichen statistischen Verfahren und Methoden in der Hydrologie analysieren, vergleichen und bewerten.

Teaching and Learning Methods:
¿ Theoretische Inhalte werden in einer Reihe von Vorlesungen erläutert und im Rahmen der Seminare zur Vermittlung der theoretischen Inhalte vertieft.
¿ Die Anwendung der Methoden findet im Rahmen von Computerübungen zur Anwendung der Methoden anhand praxisbezogener Beispiele statt.

Media:
¿ Power-Point-Folien
¿ Themenbezogene Theorie- und Übungsblätter
¿ Literaturauszüge und Publikationen

Reading List:
¿ Sachs, L. & J. Hedderich (2009): Angewandte Statistik - Methoden mit R. 13. Auflage. Springer-Verlag, 2009
¿ Toutenburg H. et al. (2009): Arbeitsbuch zur deskriptiven und induktiven Statistik. Springer Verlag

Responsible for Module:
Prof. Dr.-Ing. Markus Disse

Courses (Type of course, Weekly hours per semester), Instructor:
LV 0000004325 Hydrologische Statistik
Prof. Dr.-Ing. Markus Disse
Prof. Dr. Gabriele Chiogna
Dr.-Ing. Wolfgang Rieger

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

Technische Universität München

Module Description

BGU54023: Laboratory Hydrological Measurement

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
Bei der Prüfungsleistung handelt es sich um eine Laborleistung: Die Prüfungsleistung besteht aus der Bewertung von Messprotokollen nach Inhalt und Form, die durch die Studierenden während der Messungen und Versuche erstellt werden. Die Protokolle werden zwischen Studierenden und Betreuenden diskutiert und ausgewertet.

Durch die Erstellung der Messprotokolle begleitend zu den Versuchen, weisen die Studierenden nach, dass Sie in der Lage sind, selbstständig für eine gegebene Fragestellung, eine passende Messanordnung auszuwählen, diese korrekt aufzubauen, Versuche und Messungen nach den geltenden Normen durchzuführen und eigenständig, die Messergebnisse zu protokollieren, auszuwerten und zu interpretieren.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundkenntnisse in Hydrologie
Besuch der Vorlesung Umweltmonitoring und Wasserqualität
Kenntnisse in Skriptsprachen (Python oder Bash)

Content:
1. Einführung und Theoretischer Hintergrund
¿ Einführung in hydrologische Messverfahren
¿ Einsatzgebiete und Nutzen von hydrologischen Messverfahren
¿ Klassifizierung und Einordnung
¿ Auswerteverfahren

2. Laborübungen:
¿ Abflussmessung am Messwehr
¿ Bodendurchlässigkeit (Permeameter)
¿ Bodenansprache nach EN ISO 14688

3. Feldversuche:
¿ Abflussmessung mit Hilfe von Messflügeln
¿ Pegelmessung
¿ Bestimmung der Bodenfeuchte mit Hilfe eines Feuchtesensors
¿ Versickerungstest zur Bestimmung der Bodendurchlässigkeit (Doppelring-Infiltrometer)
¿ Niederschlagsmessung (Validierung: eigene Messwerte im Vergleich mit DWD-Messstation)

4. Exkursion

Intended Learning Outcomes:
Die Studierenden nach Abschluss des Moduls in der Lage:
¿ die verwendeten hydrologischen Messverfahren, deren Einsatzgebiet und die erzielbare Genauigkeit zu kennen
¿ die Bedeutung von Messungen in der Hydrologie zu verstehen
¿ die Wechselwirkung zwischen Messgröße, Messgenauigkeit, Messwerterfassung, Messwertspeicherung, Messwertübertragung und Auswertung zu verstehen
¿ selbstständig über Art und Umfang von Messungen zu entscheiden
¿ die Messwerte zu verarbeiten
¿ die Ergebnisse von Hydrologischen Messungen im Kontext richtig zu interpretieren.

Teaching and Learning Methods:
Die Studierenden werden eingangs durch Präsentationen in den theoretischen Hintergrund und die Messverfahren eingewiesen. Die Verknüpfung zu den Grundvorlesungen Umweltmonitoring und Wasserqualität wird hierbei hergestellt.

Anschließend führen die Studierenden in Kleingruppen die Versuche durch und legen die entsprechenden Messprotokolle an. Die Versuchsauswertungen sind durch die Studierenden in Einzelarbeit zu ergänzen und zu sammeln. Jedes Messprotokoll wird durch die Studierenden zunächst selbst bewertet, dann vom Betreuer bewertet und anschließend durch die Studierenden verbessert. Am Ende der Laborübung haben die Teilnehmenden ein Kompendium an Versuchsprotokollen erstellt, welches am Ende der Laborübung als Portfolio zur Bewertung vorzulegen ist.

Die Laborübung besteht aus Labor- und Feldversuchen. Die Laborversuche werden im Labor des Lehrstuhls Hydromechanik im TUM Zentralgebäude durchgeführt. Die Feldversuche werden im Englischen Garten am Eisbach (Abflussmessung, Versickerungstest) und auf dem TUM Gelände (Niederschlagsmessung) durchgeführt.

Nach Anleitung wird von den Studierenden ein einfaches Messinstrument gebaut. Dies geschieht entweder im Eigenstudium oder in angeleiteter Arbeit zu festen Zeiten im Hydromechanik-Labor. Unter Verwendung von Kleinrechnern (Raspberry Pi) werden hierbei in Kleingruppen kontinuierlich arbeitende Niederschlagsmesserstationen aufgebaut. Die Geräte werden im Feldversuch (s.o.) validiert und angewendet.

Ergänzend stellt ein Messebesuch bei zwei Messgeräteherstellern die Praxisnähe her.

Media:
Powerpoint-Präsentation, Tafelanschrieb, digitale Vorlagen, Bauanleitung

Reading List:
- EN ISO 14688 (vormals DIN 4022)
- Häckel Hans (2008) Meteorologie, Ulmer UTB Stuttgart, 6. korrigierte Auflage
- Gerd Morgenschweis (2010), Hydrometrie: Theorie und Praxis der Durchflussmessung in offenen Gerinnen (VDI-Buch)

Responsible for Module:
Markus, Disse

Courses (Type of course, Weekly hours per semester), Instructor:
VL/UE/PR; LV 0000004698
Laborübung Hydrologische Messung
SWS: 2SWS

Karl Broich, Daniel Quosdorf

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

Technische Universität München

Module Description

BGU65008T2: Computation in Civil and Environmental Engineering Supplementary Module [BUI SM]

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
During the semester, the students create a digital building model, which is extended with the functions learned in the exercises. The progress is checked weekly.

At the end of the semester, a written examination takes place.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Attending the lectures "Civil and Environmental Informatics 1" and "Civil and Environmental Informatics 2".

Content:
¿ Erlernen von Prinzipien des modellgestützten Arbeitens (Building Information Modeling)
¿ Aufbau und Ausgestaltung von Gebäudemodellen
¿ objektorientierte Modellierung
¿ Nutzung von Gebäudemodellen für Analysen und Simulationen
¿ Modellprüfung, Modellanalyse
¿ neutrale Datenaustauschformate: IFC, GAEB, BCF, gbXML
¿ Verfahren und Technologien für das die Modellverwaltung und Koordination
¿ Finite Differenzenverfahren zur Lösung von Randwertproblemen.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltung haben die Studierenden ein vertieftes Verständnis für digitale Gebäudemodellierung (Building Information Modeling), vertiefte Kenntnisse zu Konzepten und Methoden für die Nutzung von Gebäudemodellen für Analysen und Simulationen sowie Fähigkeiten in der Nutzung von BIM-Softwareapplikationen und im Umgang von Datenaustauschformaten. Die Studierenden sind nach Teilnahme an dem Modul ebenfalls in der Lage das Verfahren der finiten Differenzen auf aus BIM abgeleiteten Modellen anzuwenden.

Teaching and Learning Methods:
Die Lernergebnisse dieses Moduls werden mit mehreren aufeinander abgestimmten Bausteinen erarbeitet. Die integrierte Veranstaltung besteht aus Vorlesungs- und Übungskomponenten. Beide Teile werden durch Powerpoint-Präsentationen, Tafelanschrieb und Code-Beispiele unterstützt. Die Studierenden haben die Möglichkeit, erlerntes Wissen selbst am Computer auszuprobieren. Zur Unterstützung stehen Tutoren zur Verfügung. Die Bearbeitung der Übungsblätter erfolgt außerhalb der Präsenzzeit.

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

Reading List:
Building Information Modeling - Technologische Grundlagen und industrielle Praxis, Editors: Borrmann, A., König, M., Koch, C., Beetz, J. (Hrsg.)

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

Courses (Type of course, Weekly hours per semester), Instructor:
Computation in Civil and Environmental Engineering Supplementary Module (lecture, 2 SWS)
Borrmann A, Braun A, Esser S, Markic S, Mundani R

Computation in Civil and Environmental Engineering Supplementary Module - Exercise (exercise, 2 SWS)
Braun A, Borrmann A, Esser S, Markic S

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

Technische Universität München

Module Description

BV000011: Building Physics Basic Module

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
Proof of performance is provided in the form of a written examination. The students should prove that the basic phenomena of building physics can be compiled, have been understood, can be presented in compressed form and procedures for evaluation can be applied. This implies basic principles of thermodynamics, moisture protection, sound insulation, lighting technology, thermal indoor climate, fire protection and urban microclimate. They should create analytical solutions to problems from the mentioned subjects under time pressure. 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:
Next semester

(Recommended) Prerequisites:
none

Content:
Heat:
- Fundamentals of heat conduction, convection and radiation
- Thermal behaviour of rooms and exterior components
- energy balances
- thermal bridges
- Transient heat conduction in components, mechanism of heat storage
- Thermal insulation materials and systems in comparison
- summer thermal insulation

Moisture:
- Relative humidity
- Water vapour content of air, water vapour partial pressure, dew temperature, diffusion resistance, liquid line
- Moisture transport by diffusion, capillary pressure and flowing air
- Avoidance of surface condensate
- Glaser process

Sound:
- Basic Acoustic Handles
- room acoustics
- Airborne and impact sound insulation
- Acoustic phenomena
- traffic noise
- installation noises

Light:
- Sun and sky, position of the sun, duration of tanning
- Basic lighting terms
- daylight quotient, illuminance distribution in rooms

Intended Learning Outcomes:
After participation in the course, the students are able to understand and calculate building physics phenomena. In addition, simple problems for the building industry in the fields of thermodynamics, moisture protection, sound insulation, lighting technology, room climate, fire protection and urban microclimate can be identified and solved.

Teaching and Learning Methods:
The module consists of a lecture and an accompanying exercise. The contents of the lecture are conveyed in the lecture and through presentations. Students should be encouraged to study the literature and the content of the topics. In the exercises the topics taught in the lecture are deepened to theoretical problems and application problems by means of short repetitions and computational tasks. As part of the exercises, text tasks supplemented with sketches and diagrams are precalculated.

Media:
Documents: scripts, lecture slides, exercises and test sheets.
Powerpoint presentations and calculations (blackboard)

Reading List:
- Gösele, Schüle, Künzel: Schall, Wärme, Feuchte. Bauverlag Wiesbaden, 10. völlig neu bearbeitete Auflage (1997).
- Lutz, Jenisch, Klopfer, Freymuth, Krampf: Lehrbuch der Bauphysik - Schall, Wärme, Feuchte, Licht, Brand - B.G. Teubner, Stuttgart (1997).
- Richter, Fischer, Jenisch, Freymuth, Stohrer, Häupl, Homann: Lehrbuch der Bauphysik - Schall - Wärme - Feuchte - Licht - Brand - Klima - Vieweg+Teubner, Wiesbaden (2008).
- Bauphysik-Kalender 2001. Hrsg. E. Cziesielski. Ernst & Sohn Verlag Berlin (2001).
- Sälzer, E.: Schallschutz im Massivbau. Bauverlag Wiesbaden (1990).
- Zürcher, Ch.: Bauphysik. Verlag der Fachvereine Zürich, (1988).
- Hauser, G., Stiegel, H.: Wärmebrücken-Atlas für den Mauerwerksbau. Bauverlag Wiesbaden, 3. durchgesehene Auflage (1996).
- Hauser, G., Stiegel, H.: Wärmebrücken-Atlas für den Holzbau. Bauverlag Wiesbaden (1992).
- Fischer, Jenisch, Stohrer, Homann, Freymuth, Richter, Häupl: Lehrbuch der Bauphysik Schall Wärme Feuchte Licht Brand Klima Vieweg+Teubner, Wiesbaden (2008).

Responsible for Module:
Klaus Peter Sedlbauer

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

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

Technische Universität München

Module Description

BV000020: Project Delivery Systems, Planning of Production and Cost Development

Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Bachelor	German	one semester	summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
5	150	90	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:
Module Fundamentals of Process-oriented Planning and Organisation (BGU55027)

Content:
Planning and Contracting:
Interaction of Investors, Planning Engineers and Civil Engineering Industry; project delivery sys-tems; assignment of controlling processes; procurement law; VOB / A; VOB / B, VOB / C; selec-tion procedures; elementary construction methods, excavations and construction pits; formwork and scaffolding; fair faced concrete; production formula, methods of production planning; rela-tionships; productivity; performance of workers, average wages; standard wage; performance of equipment; specific performance; cycles; calculation of performance; BGL; logistics; supply and disposal, production logistics; information logistics; planning of logistics, environmental law; cal-culation and costing; tendering; evaluation of cost; business overhead; project overhead; pro-duction cost, pricing; allocation of cost

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, excursions

Reading List:
Detailed lecture notes

Responsible for Module:
Josef Zimmermann (J.Zimmermann@bv.tum.de)

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

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

Technische Universität München

Module Description

BV000024: Basics of Law

Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Bachelor	German	one semester	winter semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
2	60	30	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 where the students prove not only their understanding of the learning content but also their ability to apply the methods, evaluate the results and consequences and moreover to develop the given approaches for further fields of utilization. Admissible auxiliary materials will be announced in the lecture. The test requires partly the student¿s own formulations, partly the qualifiedly checking of predefined statements.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
Fundamental understanding of structures and basics of law as background of continuative spe-cific fields of legal activity; sources of law; legislative powers; binding effect of law; legal entities, legal duties; transactions; building law; awarding public contracts; building regulations law; types of contracts; work/construction contract; general terms and conditions; law of obligations; engineering/architect contract; service/employment contract; law of tort; material rights; taxes

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, excursions

Reading List:
Detailed lecture notes

Responsible for Module:
Josef Zimmermann (J.Zimmermann@bv.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
- (lecture, 2 SWS)
Zimmermann J

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

Technische Universität München

Module Description

BV000028: Road, Railway and Airfield Construction Basic Module [GK VWB]

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The 90 minute written exam will examine the extent to which students have understood the theoretical fundamentals of the transportation infrastructure in terms of alignment, cross section design and superstructure construction and are able to apply.

The examination consists firstly of a written part (45 min without additives), in which the students should remember the fundamentals. The answer requires some own formulations, some sketches and to a lesser extent ticking given multiple answers.
In a second part (45 min , with tools), students should apply their practical skills in the alignment, based on the handling of specific case study. The weighting of the two parts of the exam is 50 %

In order to examine the competences in designing road alignments under realistic conditions ¿ which cannot be conducted within the limited time of a written exam ¿ a not graded compulsory exercise is required. Supported by tutorials the students perform a major road design task, in which they apply the methods taught in the lectures.

Repeat Examination:
Next semester

(Recommended) Prerequisites:

Content:
Alignment and Cross section-layout of road and track, earthworks, drainage systems, superstructure of roads and railway
Seminar work in road design (vertical and horizontal alignment)

Intended Learning Outcomes:
At the end of the module students are able to understand the basic principles of road and railway superstructure. They are able to apply the alignment and layout criteria, based on the handling of specific case study.

Teaching and Learning Methods:
This module is splitted in lecture /presentation of the basic topics and an excercise course of road alignment. With support of the exercise course and tutorials the students create their seminar work in road design while meeting a given deadline.

Media:
Script, powerpoint presentation, white board, etc.

Reading List:
Freudenstein, St.: Grundkurs Verkehrswegebau

Responsible for Module:
Stephan Freudenstein (stephan.freudenstein@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Road, Railway and Airfield Construction Basic Module Lecture (lecture, 2 SWS)
Freudenstein S

Road, Railway and Airfield Construction Basic Module (exercise, 2 SWS)
Freudenstein S [L], Freudenstein S, Feurig S, Stahl W, Wastlhuber T

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

Technische Universität München

Module Description

BV000029: Traffic Engineering and Transport Planning Basic Module [GM VTP]

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The examination has the form of a written 120-minute test. In a general 30-minute part, (closed book) comprehension questions are asked. Students show in this part that they can define important terms from traffic engineering and transport planning. In a 90 -minute calculation part (open book) students demonstrate that they know the design procedures for road infrastructure and can carry out the design for basic urban spaces according to the current guidelines and regulations.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Cybernetics of planning processes

Content:
Land use and transportation: mobility planning, spatial planning/zoning, transportation supply planning, transportation demand, transportation modes, traffic flow on road network, design of two-lane rural road stretches, design of uncontrolled intersections, design of controlled intersections, layout design of the street space for private transportation, layout design of the street space for public transportation, traffic noise pollution, traffic air pollution

Intended Learning Outcomes:
After completing the module, students are able to evaluate the fundamental relationships between transport supply, spatial structure and travel demand; to understand spatial development and the directive possibilities of spatial planning; to implement travel demand modeling methods as well as methods for selecting to appropriate transportation capacities (road and intersection/track and station); to evaluate the quality and performance of transport services and to analyze the impact of traffic on local conditions, the environment and society.

Teaching and Learning Methods:
The course consists of a combination of lectures and tutorials. The basic principles are taught first in the lectures and are then illustrated with examples during the tutorials. Students are able to actively increase their understanding of the material by working on similar exercises independently. Questions will be discussed in the lecture / tutorial. In addition, selected guest speakers will hold lectures to provide a direct insight into the application of the basic principles.

Media:
Presentations, detailed course notes, blackboard, film and software examples, exercises with solutions, exercises for individual practice

Reading List:
Course notes Busch / Wulfhorst: Traffic Engineering and Transport Planning Basic Module
Schnabel/Lohse: Grundlagen der Straßenverkehrstechnik und der Verkehrsplanung (Principles of Traffic Engineering and Transport Planning), publisher for civil engineering

Responsible for Module:
Univ.-Prof. Dr.-Ing. Fritz Busch (fritz.busch@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Traffic Engineering and Transport Planning Basic Module (exercise) (exercise, 2 SWS)
Busch F [L], Dumler K (Spangler M), Kinigadner J, Pajares E, Pfertner M

Traffic Engineering and Transport Planning Basic Module (lecture) (lecture, 2 SWS)
Busch F [L], Wulfhorst G (Kinigadner J, Pajares E, Pfertner M), Dumler K (Spangler M)

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

Technische Universität München

Module Description

BV000030: Hydraulic and Water Resources Engineering Basic Module

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
Mit der schriftlichen Klausur wird geprüft, inwieweit die Studierenden die grundlegenden Konzepte wasserbaulicher und wasserwirtschaftlicher Planung in begrenzter Zeit komprimiert wiedergeben können, sowie Lösungen zu Anwendungsproblemen des konstruktiven Wasserbaus auch unter zeitlichem Druck aufzeigen können. Hilfsmittel sind nicht zugelassen außer ein nicht programmierbarer Taschenrechner und eine in der Prüfung ausgehändigte Formel- und Grafik/Tabellensammlung.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge in Mathematics and Physics

Content:
The main goal in this module is to give an overview in the main aspects of water resources management and hydraulic engineering.

Precipitation and Runoff processes will be explained and also stochastic methods to determine flood frequencies for flood management.

Several water projects will be explained e.g. the planning and building of dams and weirs. Flood polders, flood retention basins, dikes (levees) will also be explained.

River engineenring problems like bedload and sediment transport will be mentioned in basics.

The German DIN-norm and other water relevant rules will be presented.

During summer semester a one-day excurion to an actual water project will be conducted.

Intended Learning Outcomes:
The students will understand the basic elements and features in water resources management and hydraulic engineering. The will be able to plan simmple projects in river and dam engineering.

Teaching and Learning Methods:
Die Vorlesungen werden durch Tafelarbeit undPowerPoint-Präsentationen unterstützt, um so den Studierenden die angesprochenen Problematiken möglichst einprägsam näher zubringen. Durch eingestreute Übungsstunden erhalten die Studierenden die Gelegenheit, den Stoff an praktischen Beispielen intensiver zu verstehen und

besondere Problemfälle zu erkennen. In Ergänzung zu Vorlesung und Übung werden freiwillig zu bearbeitende Aufgabenblätter angeboten, in denen der Stoff vertieft und geübt wird. Anschauliche Beispiele bereits gebauter wasserbaulicher Anlagen, sowie die Auseinandersetzung mit Schadensfällen, die bei Wasserbauprojekten weltweit aufgetreten sind, ergänzen den Vorlesungsstoff. Hier wird durch Diskussion versucht, Lösungsansätze zur Schadensvermeidung zu finden und Best Practise Beispiele herauszuarbeiten.

Media:
German Script
Excursion
Visit of the HydroLab in Obernach
Powerpoint Presentation
Blackboard work
Videos

Reading List:
"Wasserbau: Grundlagen, Gestaltung von wasserbaulichen Bauwerken und Anlagen",
von Heiz Patt und Peter Gonkowski, Springer Verlag, Berlin, 2011

"Wasserbau: Aktuelle Grundlagen, neue Entwicklungen",
von Theodor Strobl und Franz Zunic,
Springer Verlag, Berlin, 2006

Responsible for Module:
Prof. Dr. Peter Rutschmann (peter.rutschmann@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Hydraulic and Water Resources Engineering Basic Module (lecture, 4 SWS)
Rutschmann P

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

Technische Universität München

Module Description

BV000038: Technical Mechanics - Supplementary Module

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The learning outcome is confirmed by passing a 90 minute examination.
The aim of the written examination is the confirmation that the necessary processes for the description of continuum mechanical and structurally dynamic questions such as the principle of work, the formulation of equilibrium, the classification of single and multiple degree of freedom systems (SDOF & MDOF) and the determination of dynamic inner quantities are understood, can be concisely repeated and implemented. Furthermore, problems must be analyzed and solution approaches found and applied within a limited time using the learning outcomes achieved during the module.

The solutions sometimes require the student`s own interpretation, in part selection of Single or Multiple Choice answers, whereby the emphasis is on short calculation exercises.

No auxiliary means are allowed in the exam with the exception of a collection of formulae (provided) and a scientific calculator.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The lectures Technische Mechanik I and II are required for this module.

Content:
In continuum mechanics the focus is laid on the development of selected continuum mechanical solutions by means of energy methods, principle of virtual work and weighted residuum methods.
Basic methods for structural dynamics are refined for structural engineers. Knowledge of structural dynamic effects is of importance for the examination of loads induced by wind, earthquakes, pedestrians, vehicles etc.
Approximative methods, which are useful practical engineering tasks, e.g. for the determination of natural frequencies are offered. The relevant structural dynamical load cases for practical problems like vibrations caused by pedestrians, wind, earthquakes or church bells are discussed.
In addition dynamical loads of moving systems are explained.

Contents:

I. Newton¿s law, d'Alembert's principle
II. Energy methods
III. Free damped vibrations
IV. Forced damped vibrations
V. Damped vibrations caused by ground movement

VI. Vibration of an Euler-Bernoulli-beam
VII. Approximation of natural frequencies
VIII. Axial linear motion
IX. Plane motion of a mass
X. Plane motion of a plate
XI. Rolling and sliding
XII. Impulse and energy considerations
XIII. Ideal central shock of compact bodies
XIV. Angular momentum
XV. Internal forces caused by movement

Intended Learning Outcomes:
After passing this course the students are able to identify the limits of assumptions, e.g. those made within Technical Mechanics for the beam-theory, and develop a deep understanding for possible solutions. The students are able to implement procedures to establish the equation of motion and to mechanically describe the systems that are dealt with. Furthermore they are able to analyze dynamical systems and evaluate the response of a structure.
The students are able to calculate dynamic systems' internal forces and to determine the vibration characteristics of single degree of freedom systems, multi degree of freedom systems and elastic, mass distributed structures.

Teaching and Learning Methods:
The module consists of lectures and seminars. The topics of the lecture are taught with the help of presentations, real and abstract models as well as via discussions with the students. Further the lecture should encourage the students to enrich their studies through additional literature. In the scope of the seminars selected examples and concrete problem tasks are handled. Furthermore voluntary exercise sheets are provided with which the concepts of dynamics can be fully internalized and practiced.

Media:
- Lecture notes with additions during the lectures (Tablet-PC with projector)
- Notes based on the blackboard notes during the exercises
- Small models, springs, cable, rubber foam systems
- Films and animations
- Implementation of example problems in Computer Algebra Systems

Reading List:
Gross,Hauger,Schröder,Wall: Technische Mechanik 3 - Kinetik, Springer Verlag
Kramer: Angewandte Baudynamik, Ernst & Sohn
Bachmann: Vibration problems in structures, Birkhäuser
Petersen: Dynamik der Baukonstruktionen
Clough, Penzien: Dynamics of Structures

Responsible for Module:
Prof. Dr.-Ing. Gerhard Müller

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

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

Technische Universität München

Module Description

BV000040: Project Execution, Cost and Activity Controlling

Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Bachelor	German	one semester	summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
5	150	90	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:
Module Project Delivery Systems, Planning of Production and Cost Development (BV000020)

Content:
Execution of Projects:
Implementation of Civil Engineering Projects based on Processes; Elementary Construction Methods; bridges, tunneling, special underground engineering; VOB/B (compensation and execution, disruption, modification, taking over, payment), contract management (types of contract, achievement, deviation, claim management, project management); quality controlling, quality assurance, planning of quality, ISO 9000, controlling of cost, fundamentals of economy; calculation on tender/contractual and prognostic level, corporate accounting, determination of revenue; balancing costs, calculation according to budgets, controlling of dates and sequences, detailing plans of dates/sequences, taking over and claim for defects; safety, compliance

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, excursions

Reading List:
Detailed lecture notes

Responsible for Module:
Josef Zimmermann (J.Zimmermann@bv.tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Project Execution, Cost and Activity Controlling (lecture, 2 SWS)
Zimmermann J

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

Technische Universität München

Module Description

BV000041: Building Physics - Supplementary Module

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
Exam duration (in min.): 60 min.
Proof of performance is provided in the form of a 60-minute written examination. The aim of the written test is to demonstrate that deeper principles of heat transport, in particular transient phenomena and related phenomena of moisture protection (mould, condensation, etc.) have been understood 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 lecture. 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 (prerequisite)

Content:
Transient one-two and three-dimensional heat transport.
More complex phenomena of moisture protection, especially when mould and condensation problems occur.
Interrelations which occur with the two phenomena mentioned above, e.g. at thermal bridges.

Intended Learning Outcomes:
After participating in the course, students will be able to analyse phenomena of dynamic heat transport and moisture protection and their correlations. Furthermore, problems occuring due to dynamic and static heat transport can be evaluated in this context.

Teaching and Learning Methods:
- lecture
- exercise (e.g. thermal bridge calculations with computer programmes)

Media:
- transcript, board
- powerpoint-presentation,
- software presentation

Reading List:
- see recommendations during the lectures

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.

Technische Universität München

Module Description

BV000045: Tunneling [TB]

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
Description of achievement and assessment methods:
Proof of performance takes place in the form of a 60 minute written exam.
The exam divided into two parts:
The first approx. 30 minute part consists of general questions with unrestricted formulations. In this part no aids (only pens, set square, compass) are allowed. It will be proven, that the students have developed an understanding for the convayed fundamental relationships of tunneling within the scope of the module. These include:
- Geotechnical investigation methods
- Rock mass strength and rock mass classification
- Construction processes in tunneling

The focus of the answers in this part lies on individual shorthand formulations. In part, small calculation problems must also be solved.
A second approx. 30 minute part consists of calculations and dimensioning tasks. As an aid all study documents, literature and a basic academic calculator are allowed. It will be proven, that students are capable of analyzing and solving technical tunneling calculations in a limited amount of time. These include:

- Statics of tunneling structures
- Characteristic-curve method
- Structural stability of the tunnel heading face

The answers in this part require extensive calculations. In part, short individual formulations are necessary.
The final grade is compsed of the respective time emphasis.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The following modules should be passed: (Notice: The contents of the modules can be found in the respective module manuals (handbooks).)
- Foundation Engineering and Soil Mechanics Base & Supplementary Module (BV000019 and BV500006)
- Technical Mechanics I (BV000001)
- Technical Mechanics II (BV000004)
- Advanced Mathematics I (MA9517)
- Advanced Mathematics II (MA9512)

Content:
- Geotechnical investigation methods

- Rock mass strength and rock mass classification
- Statics of tunneling structures
- New Austrian Tunneling method
- Drill-and-blast driving
- Shield driving
- Micro tunnelling

Intended Learning Outcomes:
After participating in the module the student is able to
- remember investigation methods for soil and rock
- understand field and laboratory investigation methods
- apply structural analysis verification methods
- analyze driving methods and their respective requirements for tunnels with small diameters
- evaluate various driving techniques in existing subsurface conditions

Teaching and Learning Methods:
The lecture is intensively assisted by a PowerPoint presentation, whereby the students can directly profit from the experience of the lecturer. In part, demonstration materials for a better illustration of the lecture facts will be handed out. Films concerning experiments and procedures are integrated, as well as an excursion to a reachable construction site. The contents of the lecture are deepened by exercise courses. During the exercises lecture notes to be completed by the students are used to deepen the topics of the lecture with calculation examples. An extensive voluntary term paper is handed out close to the end of the lecture, which deepens the learned material. The term paper can be discussed in an oral submission dialogue.

Media:
lecture notes, Powerpoint-presentation, field trips, blackboard, demonstration lab tests, films

Reading List:
FILLIBECK, J, HÖFLE, R. lecture notes "Tunnelbau"
KOLYMBAS, D. (2005) Tunneling and Tunnel Mechanics, Springer Verlag
MAIDL, B. (2004) Handbuch des Tennel- und Stollenbaus, Verlag Glückauf
STEIN, D. (2003) Grabenloser Leitungsbau, Ernst & Sohn,

Responsible for Module:
Dr.-Ing. habil. Jochen Fillibeck j.fillibeck@bv.tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Vorlesung 1,5 SWS
Übung 1,5 SWS
Dr.-Ing. habil. Jochen Fillibeck j.fillibeck@bv.tum.de
Sven Manthey M.Sc., s.manthey@tum.de

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

Technische Universität München

Module Description

BV000046: Road, Railway and Airfield Construction - Supplementary Module [EK VWB]

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
Splitted written exam with a duration of 90 minutes. First, a theoretical part with short questions (closed book) to demonstrate that the students can analyse and evaluate general basics of traffic infrastructure. In the second part students have to demand calculations of railway layout and design (calculator and script allowed)

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Grundmodul Verkehrswegebau (BV000028)

Content:
Complemental topics of structual design and complemental topics of the railway superstructure switches, railway infrastructure, railway safety devices, noise protection and calculation on roads and railways.

Intended Learning Outcomes:
At the end of the module students are able to analyse noise protection measures and to apply the knowledge of special topics as crossings and safety systems. They are able to evaluate road and railway superstructures as well.

Teaching and Learning Methods:
The course is primarily a classical lecture with ongoing support through a Power Point presentation . Films for illustration of practical aspects are integrated in the presentations. The lecture material is deepened by means of exercises. Voluntary homework upon the practical tasks is given ¿ students receive feedback and corrections.

Media:
script, powerpoint presentation, white board, etc.

Reading List:
-Freudenstein, St.: Grundkurs Verkehrswegebau -
Freudenstein, St.: Ergänzungskurs Verkehrswegebau

Responsible for Module:
Stephan Freudenstein (stephan.freudenstein@vwb.bv.tum.de)

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

Technische Universität München

Ergänzungskurs Verkehrswegebau Vorlesung 1 SWS
Stephan Freudenstein (stephan.freudenstein@tum.de)

Ergänzungskurs Verkehrswegebau Übung 1 SWS
Sophie Feurig (sophie.feurig@tum.de)

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

Technische Universität München

Module Description

BV000047: Traffic Engineering and Transport Planning - Supplementary Module [EM VTP]

Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Bachelor	German	one semester	summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
4	120	84	36

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

Description of Examination Method:
The examination has the form of a written 90-minute test. In a general 20-minute part, (closed book) comprehension questions are asked. Students show in this part that they can define important terms from traffic engineering and transport planning and that they understand simple interrelations between travel demand, the planning of transport systems and traffic safety. In a 70 -minute calculation part (open book) students demonstrate that they know the design procedures for road infrastructure and can carry out the design for basic urban spaces according to the current guidelines and regulations. Additionally, students show that they can carry out a cost estimate for simple road systems.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Traffic Engineering and Transport Planning Basics

Content:
Design of road stretches and uncontrolled intersections on highways, direction of traffic flow, coordination of traffic signals, design of parking facilities, road traffic safety, design of interchanges, local mobility, neighborhood traffic calming, costs and financing, transport concepts

Intended Learning Outcomes:
At the end of the module students know the theoretical basics of traffic safety and transportation concepts. Students will can assess basic concepts of mobility and transportation management in private and public transport as well as to develop measures to influence transportation behaviour. Additionally, students will gain the ability to design highways, bus stations and parking facilities, calculate costs and identify funding schemes for public transport operations. Students will also be able to plan traffic calmed areas.

Teaching and Learning Methods:
The course is a classic lecture that is supported by Powerpoint presentations that include short videos. The lecture material is reinforced by classroom exercises, which are comprised of course notes with blanks that can be filled in using calculation examples given in the lecture. Additional exercise sheets will be distributed for exam preparation and can be completed on the students own time (optional).

Media:
Lecture notes, tutorial notes, Powerpoint presentation

Reading List:
Skript: Busch/Wulfhorst: Ergänzungsmodul Verkehrstechnik und Verkehrsplanung
Schnabel/Lohse: Grundlagen der Straßenverkehrstechnik und der Verkehrsplanung, Verlag für das Bauwesen
Forschungsgesellschaft für Straßen- und Verkehrswesen: HBS - Handbuch für die Bemessung von Straßenverkehrsanlagen (2001, Fassung 2005) Forschungsgesellschaft für Straßen- und Verkehrswesen: RAA (Ausgabe 2008) - Richtlinien für die Anlage von Autobahnen
Forschungsgesellschaft für Straßen- und Verkehrswesen: RASt 06 - Richtlinien für die Anlage von Stadtstraßen
Forschungsgesellschaft für Straßen- und Verkehrswesen: RiLSA (Ausgabe 2010) - Richtlinien für Lichtsignalanlagen Forschungsgesellschaft für Straßen- und Verkehrswesen: HVÖ (Ausgabe 2009) -Hinweise für den Entwurf von Verknüpfungsanlagen des öffentlichen Personennahverkehrs
Forschungsgesellschaft für Straßen- und Verkehrswesen: EAR - Empfehlungen für Anlagen des ruhenden Verkehrs (Ausgabe 2005) Bell, Quddus, Schmöcker, Fonzone: Short- and Long-term Impacts of the term Impacts of the Congestion Charge on central London. Verkehr Aktuell, Deutsches Museum Verkehrszentrum. München, 07.12.2006
MOBINET Abschlussbericht Arbeitsbereich A Beeinflussung der Verkehrsmittelwahl der Pendler durch intermodale Maßnahmen
MOBINET Abschlussbericht Arbeitsbereich B Optimierung des Verkehrs im Hauptstraßenetz
MOBINET Abschlussbericht 2003, 5 Jahre Mobilitätsforschung im Ballungsraum München
Stadt Graz Verkehrsplanung und Straßenamt
www.muenchen.de/Rathaus/plan/stadtentwicklung/verkehrsplanung/vep_neu/97330/basiszenario.html
LH München: Der neue Verkehrsentwicklungsplan - Entwurf 2004. München 2004
LH München Handlungs- und Maßnahmenkonzept im Rahmen der Verkehrsentwick-lungsplanung; München 2004
Greater London Authority: The Mayors Transport Strategy; London 2001

Responsible for Module:
Univ.-Prof. Dr.-Ing. Fritz Busch (fritz.busch@tum.de)

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

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

Technische Universität München

Module Description

BV000048: Hydraulic Structures and Water Resources Engineering Supplementary Module

Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Bachelor	German	one semester	summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
5	180	120	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 test, in which students have to answer general questions about the hydraulic key areas and modelling approaches without tools (closed book exam). In addition, simple transfer tasks have to be solved using the taught modelling approaches, thus the student can show that they understood the main concepts.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Hydraulic Structures and Water Resources Eingineering Basic Module

Content:
Model / Methods in hydraulic engineering

1. Numerical Modelling
- Theory and Fundamentals
- 2D flood computation

2. Dimensional Analysis
- Theory and Fundamentals
- Examples (contaminant transport)

3. Physical Experiments
- Theory and Fundamentals
- Obernach Workshop (Driftwood, Sunk and Schwall, Kolk)

Water engineering topics:

1. Water and Risks
- Flood, Mountain Risk
2. Water and Life
- Habitat modeling, EU Water Framework Directive
3. Water and Energy
- Hydropower, German Renewable Energy Act

Intended Learning Outcomes:
After attending the course the students will be able to
- understand the basic modeling approaches in hydraulic engineering and apply these for simple cases independently.
- describe and to outline the major relationships and details of hydraulic key areas (risks, life, energy).
- apply memorized methods and modelling approaches to simple problems.
- analyze and solve simple tasks using a learned method.
- recognize, to understand and to differentiate various hydraulic issues.

Teaching and Learning Methods:
The theoretical content of the lectures are presented by the lecturer and supported by PowerPoint slides and the traditional black board method. Accompanying exercises and discussions on real case studies allow students to participate and to strengthen the interdependencies.
For a better understanding of each modeling approach and the major details of the hydraulic key areas a conjoint application-oriented examples are given. These field-specific examples have to be solve in small groups at the hydraulic laboratory, at the computer-lab or in the lecture hall. The working on exercises and experimental work within the Obernach-Workshop enable students to understand and grasp their memorized knowledge.

Media:
Explanations on blackboard
PowerPoint presentationen

Reading List:
"Wasserbau: Grundlagen, Gestaltung von wasserbaulichen Bauwerken und Anlagen",
von Heiz Patt und Peter Gonkowski, Springer Verlag, Berlin, 2011

"Wasserbau: Aktuelle Grundlagen, neue Entwicklungen",
von Theodor Strobl und Franz Zunic,
Springer Verlag, Berlin, 2006

Responsible for Module:
Dr. Wilfried Knapp (wilfried.knapp@tum.de)
Prof. Dr. Peter Rutschmann (peter.rutschmann@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
LV-Nr. 820887261
Prof. Dr. Peter Rutschmann
Dr. Arnd Hartlieb
Dr. Richard Huber
Dr. Wilfried Knapp
Tobias Liepert

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

Technische Universität München

Module Description

BV000049: Construction in Hydraulic Engineering

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The examination is a written test.
The aim of the written test is to verify that basic understanding of the Hydraulic Engineering can be reproduced and applied in a short span. This is done in the form of theoretical questions and short calculation tasks as well as construction design tasks.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic competences in Hydraulic Structures and Water Resources Engineering

Content:
- types of embankment dams and statiscs
- types of concrete dams and statiscs
- sealing systems
- gauging and controlling systems
- operation structures
- weirs and barriages
- construction works

Intended Learning Outcomes:
Upon completion of the module, students will be able to
- produce technical drawings of basic hydraulic engineering tasks
- draw technical details of hydraulic plants
- apply constructive tasks in hydraulic engineering in technical drawing
- assess the quality of technical drawings and solutions related to hydraulic engineering

Teaching and Learning Methods:
The course consists of two parts. Lectures in the first part provide a more comprehensive overview of the hydraulic structures that were covered in the Basic Module. Different types of dams and weirs are taught, as well as their particular functioning. Also covered are the criteria for designing these structures. Special attention is paid to operational equipment, measurement and control devices as well as subsurface sealing for dams. A special

chapter is dedicated to weirs and the different types of structures available. Fish bypass structures are covered as well.

The second part of the course entails a practical exercise. Under the supervision of teaching staff, the students design a complete dam or weir structure based on a realistic situation. Depending on need, particular problems will be discussed in the group or dealt with on a per-student basis.

Media:
Part 1: Blackboard and PowerPoint; script
Part 2: Script and task sheet with check list etc.

Reading List:
"Wasserbau: Grundlagen, Gestaltung von wasserbaulichen Bauwerken und Anlagen",
von Heiz Patt und Peter Gonkowski, Springer Verlag, Berlin, 2011

"Wasserbau: Aktuelle Grundlagen, neue Entwicklungen",
von Theodor Strobl und Franz Zunic,
Springer Verlag, Berlin, 2006

Responsible for Module:
Franz Zunic (franz.zunic@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
LV-Nr. 820632289
Dr.-Ing. Richard Huber
Dr.-Ing. Arnd Hartlieb
Stefan Hötzl
Tobias Liepert
Stefan Giehl

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

Technische Universität München

Module Description
BV000121: Road and Environment

Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Bachelor	German	one semester	summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
2	60	45	15

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

Description of Examination Method:
The Examination will consist of a 60 minute.

The purpose of the written test is to verify that the planning processes for complex infrastructure projects. The complex problems of nature conservation must cursory reproduced and used for short case studies, possibly using explanatory sketches applied.

The answers require own formulations and sketches. Sometimes the questions can be answered by multiple choice.

This is a closed book exam.

Repeat Examination:

(Recommended) Prerequisites:
Road, Railway and Airfield Construction Basic Module (BV000028)

Content:
Conditions for road and rail transport in Germany
Planning process of complex infrastructure projects
Nature conservation and natural legal framework for the design of roads
Processes of environmental impact assessment
European nature protection legislation (habitat protection , species protection)
Environmentally friendly road planning

Intended Learning Outcomes:
After attending the module, the students understand planning processes of infrastructure projects. Furthermore, the students know the relevant nature conservation rules and can understand and transferred them to similar situations. By using sketches, students will be able to explain the contents.

Teaching and Learning Methods:
The module is a traditional lecture with ongoing support through a Power Point presentation and explanatory video sequences. Actual reference to current complex road planning is given by the contact to the federal road

administration.

Media:
Script,powerpoint presentation, video clips, white board

Reading List:
Skript: -Straße und Umwelt
-Freudenstein, St.: Grundkurs Verkehrswegebau

Responsible for Module:
Stephan Freudenstein (stephan.freudenstein@tum.de)

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

Wolfgang Wüst
(wolfgang.wuest@tum.de)

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

Technische Universität München

Module Description

BV000123: Field Course Environmental Geology [Ing-UWI-G]

Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Bachelor	German	one semester	summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
3	45	17	28

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

Description of Examination Method:
Ausarbeitung eines Geländeberichtes für einen der angebotenen Geländetage; Damit soll nachgewiesen werden, inwiefern die Studierenden die wesentlichen Aspekte zu ausgewählten Themen der angewandten Geologie, die ihm während des Geländetages vermittelt wurden (z.B. Funktionsweise einer Klär-, Grundwasserreinigungs-, und Geothermieanlage, Einschätzung von Naturgefahren wie Hangbewegungen und Permafrost, Kennenlernen der Münchner Wasserversorgung), verstanden haben und strukturiert wiedergeben können, sowie die Einzelergebnisse/praktischen Beispiele zu Themen der angewandten Geologie im Kontext der Umweltsicherung analysieren und bewerten können.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Abriss der Hydrogeologie (BV660006), Einführung in die Geologie für Umweltingenieure (BGU 000036)

Content:
Hydro- und Ingenieurgeologie in der Umweltsicherung an praktischen Beispielen. Dabei ist entweder der Veranstaltung eine 45-minütige Vorlesung vorgeschaltet oder es findet ein wissenschaftlicher Vortrag von den leitenden Dozenten und/oder eingeladenen Experten vor-Ort statt. Für ausgewählte Veranstaltungen werden durch aktive Teilnahme der Studenten chemische, isotopenchemische oder hydraulische Parameter gewonnen und im Labor analysiert oder direkt vor Ort gemessen und interpretiert. Das Programm kann je nach den zu organisierenden Möglichkeiten variieren.
Entsorgung:
¿ Kläranlage und Deponie München Nord (Großlappen).
¿ Müllverbrennungsanlage (München Nord, Geiselbullach).
Energie:
¿ Tiefengeothermiebohrung (z.B. München-Sauerlach), Geothermie-Heizkraftwerk Pullach.
Wasser:
¿ Trinkwasserversorgung München: Trinkwassergewinnung Mangfalltal oder Loisachtal.Klimawandel
¿ Grundwasserschadensffall Kirchseeon
¿ Funnel & Gate System Pasing
Klima:
¿ Umweltforschungsstation Schneefernerhaus/Zugspitze

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage ihr in den Vorlesungen erlangtes theoretische Wissen im Bereich Energie, Wasser, Entsorgung durch Beispiele aus der Praxis zu

vertiefen, z.B. die Trinkwasserversorgung der Stadt München kennenzulernen, die Geologie und Schutzkonzepte einer Trinkwasseranlage zu verstehen, und die Vor-Ort eingesetzten Methoden (Isotopenchemie, Wasserchemie, Spurenanalytik) zu diskutieren, um die Herkunft und Gefährdung des Münchner Trinkwassers zu verstehen.

Teaching and Learning Methods:
Geländeübungen mit Demonstrationen, Beobachtung und Diskussion von Prozessen und deren Ergebnissen, wissenschaftliche Vorträge.

Media:
Folien, Skripten und Publikationen zum Download sowie Links in Moodle;

Reading List:
Folien, Skripten und Publikationen zum Download sowie Links in Moodle;

Responsible for Module:
Florian Einsiedl (f.einsiedl@tum.de)

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

Prof. Dr. Florian Einsiedl
Dr. Kai Zosseder
Dr. Anja Wunderlich

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

Technische Universität München

Module Description

BV000124: Photogrammetry and Remote Sensing II [PF2]

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The written exam takes 60 minutes. It contains questions on principal understanding and assessment of methods as well as calculation tasks to solve practical examples. By drawing sketches the geometric understanding of different recording geometries is proved.
No aids are allowed.
The additional program during the exercises contains tutor lessons and homework. These lessons are used to discuss and exploit solutions for practical problem. In the homework the practical skills are further deepened. A report hast o be given for every homework to ensure the probability ot write scientific reports on experiments.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
- Basics in matrix mathematics
- Matlab basics
- Photogrammetry and Remote Sensing 1

Content:
- Mathematical fundamentals of single images
- Interior and exterior orientation
- Basics in image processing
- Rectification
- Mathematical fundamentals of stereo images
- Forward section
- Accuracy of reconstructed bject coordinates
- Epipolar geometry
- Stereo measurement
- Digital image registration
- Automatic orientation
- Mathematical fundamentals of bundle blocks
- Aerotriangulation
- Self calibration
- Automatic aeorotrinagulation (AAT)
- Combined point extractoin
- Digital terrain models, ortho images, data proessing for GIS

Intended Learning Outcomes:
Participants are capable to:
- Understand the mathematical fundamentals of Photogrammetry
- Perform image orientation (single images, stereo images, bundle blocks)
- Perform stereoscopic measurement ins stereo models
- Produce rectified images and ortho images
- Generate digital terrain models
- Generate vector data for GIS applications

Teaching and Learning Methods:
Lecture: Slides, lecture notes, small exercises
Exercise: seminary style, computer, homeworks

Media:
Lecture: Slides, lecture notes, whiteboard
Exercise: Slides, lecture notes, computer

Reading List:
none

Responsible for Module:
Uwe Stilla (stilla@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
LV820024948 PF2 ¿ Photogrammetrie und Fernerkundung 2 (Vorlesung 2SWS: Prof. Uwe Stila)
LV820008984 PF2Ü ¿ Übung zu Photogrammetrie und Fernerkundung 2, (Übung 1SWS: Dr. Ludwig Hoegner, Dipl.-Ing. Konrad Eder)

Uwe Stilla (stilla@tum.de)

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

Technische Universität München

Module Description

BV000125: Satellite Remote Sensing [SF]

Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Bachelor	German	one semester	summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
2	60	30	30

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

Description of Examination Method:
Prüfungsdauer (in min.): 60.
Im Laufe des Semesters wird von den Studierenden die Ausarbeitung von zwei Übungen erwartet. Hausübungen sind nichtbenotete Studienleistungen. Die Modulnote ergibt sich aus der Note der schriftlichen Prüfung.

Repeat Examination:
End of Semester

(Recommended) Prerequisites:
Erforderlich sind Grundkenntnisse in Photogrammetrie, Mathematik und Physik.

Empfohlene Voraussetzungen sind die Module:
- Photogrammetrie und Fernerkundung - Einführung

Content:
Die Modulveranstaltung vermittelt die Grundlagen der Fernerkundung und gibt einen Überblick über die Aufgabenfelder, Methoden und Anwendungen:
- Einleitung und Motivation
- Hyperspektralfernerkundung
- Thermalfernerkundung
- Multispektralklassifikation
- Mikrowellen
- SAR Grundlagen
- Ozeanfernerkundung
- Atmosphärenfernerkundung
- Datenrecherche
- Bodensegment Missionsaspekte
- Erdbeobachtungssysteme

In praktischen Übungen werden die Multispektralklassifikation und die Datenrecherche von Satellitendaten behandelt.

Intended Learning Outcomes:
Nach der Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage, verschiedene Aufgaben der Fernerkundung zu verstehen sowie die Methoden der Fernerkundung anzuwenden.

Teaching and Learning Methods:
In der Vorlesung wird das Verständnis für die Grundprinzipien der Fernerkundung sowie deren Methoden und Anwendungen vermittelt. Rechnungen und Herleitungen werden an der Wandtafel ausgeführt.

In den Übungen, in welchen u.a. ERDAS eingesetzt wird, erlernen die Studierenden die Anwendung der Methoden zur Lösung von Aufgaben der Photogrammetrie und Fernerkundung.

Media:
In der Vorlesung wird Powerpoint sowie die Wandtafel verwendet. In den Übungen wird ERDAS eingesetzt. Vorlesungsskript wird in analoger Form zur Verfügung gestellt.

Reading List:
Vorlesungsskript

Albertz, Wiggenhagen: Taschenbuch zur Photogrammetrie und Fernerkundung. Wichmann Verlag

Responsible for Module:
Richard Bamler (Richard.Bamler@dlr.de)

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

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

Technische Universität München

Module Description
BV000126: Environmental Analysis

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The attendence in the lecture series is mandatory for the exam.
The written exam takes 60 minutes.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
The course consists of an introduction into environmental chemistry. Definition and determination of critical values for aquatic and terrestric systems are described. Origin of the harmful substances are explained. Taking of environmental probes is shown as well as methods of the instrumental analytics like spectrometry ((UV/VIS, IR, NMR, AAS) and separation of substances (GC, GC/MS, HPLC, HPLC/MS).

Intended Learning Outcomes:
Students can estimate the basics of modern environmental analysis, origin. They can analyse the characteristics of the relevant environmental toxic elements, band of concentration of toxic elements in the environmental media water, soil and air.

Teaching and Learning Methods:
lecture, exercises

Media:
blackboard, beamer, script (50 pages)

Reading List:
Claus Bliefert, Umweltchemie, VCH (1994)
Stanley Manahan, Environmental Chemistry, CRC Press (2005)
Ibanez et al., Environmental Chemistry, Springer, (2007)
Hein und Kunze, Umweltanalytik, VCH (1994)
Deutsche Einheitsverfahren der Wasser-, Abwasser- und Schlammanalytik (DEV), VCH (Loseblattsammlung)

Responsible for Module:
Oliver Knoop (oliver.knoop@tum.de)

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

Oliver Knoop

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

Technische Universität München

Module Description

BV000331: Environmental Law

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The module examination consists of a 60 -minute exam. It consists of theoretical questions that must be answered with own formulations, The students verify they have understood the principals and the execution of environmental approval procedures.

Repeat Examination:

(Recommended) Prerequisites:
-

Content:
The lecture consists of an introduction into basics of environmental law, especially the immission control law, water right and waste legislation. Basics of the general administrative law and the cycle of environmental approval procedure are shown.

Intended Learning Outcomes:
After completing the module, students are able to accomplish environmental approval procedures.

Teaching and Learning Methods:
Lectures and presentations give insight in basic theoretical concepts. Through the presentation of realistic case studies, students learn the practical application of the theory.

Media:
Powerpoint, Scriptum

Reading List:
-

Responsible for Module:
Brigitte Helmreich (b.helmreich@bv.tu-muenchen.de)

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

Martin Spieler

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

Technische Universität München

Module Description

BV170080: Hydrological and Pedological Field Exercises [HFM GÜ]

Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Bachelor	German	one semester	summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
3	90	40	50

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

Description of Examination Method:
Die Studierenden fertigen in kleinen Gruppen Berichte (15 ¿ 20 Seiten) zu jeweils einem innerhalb der Geländeübung behandelten Thema (z.B. Infiltrationsmessung, Bodenbestimmung, Bodenfeuchtebestimmung, Abflussmessung,¿) an. Hierzu werten sie für die jeweilige Messmethodik die Daten aller Gruppen für den gesamten Zeitraum aus. Jede Gruppe stellt ihren Bericht in einer 20-minütigen Präsentation vor und wird in einem anschließenden Kolloquium zu allen innerhalb der Geländeübung behandelten Themen (s.o.) befragt.
Demnach errechnet sich die Gesamtnote wie folgt:
a) Bericht inkl. Präsentation zu einem Thema (Gruppennote, Gewichtung 66,66 %)
b) Mündliche Prüfung zu allen Themen (Einzelnote, Gewichtung 33,33 %)
Neben der fachlichen Kompetenz werden in a) Kompetenzen wie Abstraktionsvermögen, Präsentationsstil, Sorgfalt und Teamfähigkeit bewertet.
Durch dieses Benotungsschema ist sowohl die Bewertung der Gruppenleistung als auch der individuell variierenden Kompetenzen innerhalb einer Gruppe gewährleistet.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Umweltmonitoring und Risikomanagement

Content:
Die Geländeübung wird in dem Messgebiet der DFG-Forschergruppe "Großhang" (www.grosshang.de) in Ebnit/Vorarlberg (Österreich) durchgeführt.
Folgende Themenschwerpunkte werden behandelt:
- Einführung in die Geologie, Geomorphologie und Pedologie des Messgebietes
- Durchführung von Abflussmessungen mit unterschiedlichen Methoden
- Einführung in die Feldbodenkunde, Ansprache von Bodenparametern, Entwicklung von Bodenprofilen
- Messung hydrologischer Zustandsgrößen im Boden (Bodenfeuchte, hydraulische Leitfähigkeit, Saugspannung und Bodentemperatur)
- Methoden der Niederschlags- und Klimamessung (Temperatur, Luftfeuchte, geländeklimatologische Effekte, Einfluss der Vegetation)
- Grundwasserstände im Gebiet, Tracerversuche
- Zusammenschau aller Messdaten und Interpretation

Intended Learning Outcomes:
Nach der Teilnahme an der hydrologischen und bodenkundlichen Geländeübung sind die Studierenden in der Lage:
- Messprinzipien und Instrumente anzuwenden,

- Mögliche Probleme in Abhängigkeit der Messmethodik zu identifizieren,
- Die erhobenen Daten innerhalb einfacher Aufgaben zu Regionalisierung, Wasserhaushaltsbilanzierung und Niederschlag-Abfluss-Berechnung zu benutzen,
- Durch Plausibilisierungsmethoden Messfehler zu analysieren,
- Das natürliche System als integrales Ergebnis von landschaftsbildenden Prozessen (Geologie, Pedologie, Relief, Wasserhaushalt, Klima, anthropogene Einflüsse) zu verstehen und
- Ihre angewendeten Methoden und Analysen verständlich darzustellen.

Teaching and Learning Methods:
Die hydrologische und bodenkundliche Geländeübung ist eine Geländeübung (inkl. Seminar).
Es findet primär die Lehrmethode ¿Gruppenarbeit¿ Anwendung, da einerseits die meisten Messgeräte (z.B. Tracermesssonde, ADCP-Gerät, Infiltrometer,¿) die Bedienung durch ein Messteam erfordern und andererseits hierdurch die Gestaltung der Ausbildung im Rahmen eines Stationskreislaufs realisiert werden kann. Das dadurch erzielte Kleingruppenprinzip trägt maßgeblich dazu bei, dass die Studierenden innerhalb kurzer Zeit in der Lage sind, die im Rahmen des Praktikums behandelten Messsysteme und ¿methoden anzuwenden.

Media:
Einführung in die unterschiedlichen Messgeräte und Feldmethoden in betreuten Kleingruppen

Reading List:
- H.-P. Blume et al. (2011): Bodenkundliches Praktikum. 3. Auflage, Spektrum Verlag, Produktbeschreibungen der Messtechnik
- C. Jackisch, J. Klaus, E. Zehe: (Boden-) hydrologische Feldmessmethoden, Begleitskript zur Vorlesung Umweltmonitoring und Geostatistik und zur Geländeübung. Fachgebiet für Hydrologie und Flussgebietsmanagement Technische Universität München

Responsible for Module:
Dr.-Ing. Wolfgang Rieger (wolfgang.rieger@tum.de)

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

Dr.-Ing. Wolfgang Rieger (wolfgang.rieger@tum.de)
Prof. Dr.-Ing. Markus Disse (markus.disse@tum.de)

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

Technische Universität München

Module Description

BV320005: Finite Element Method in Environmental Engineering [umw-fem]

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
In the written examination (60 minutes) students demonstrate by answering questions without helping material their knowledge and understanding of different modeling approaches for environmental engineering materials via Finite Element Methods. The answers require from the students to formulate themselves theoretical aspects complemented by rough drawings. Some questions require short calculations and mathematical derivations.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Undergraduate knowledge in Technical Mechanics (ridig and elastic bodies) and Higeher Enrgineering Mathematics

Content:
- Method of weighted Residua
- Discretization, displacement formulation, shape functions
- System matrices, boundary and initial conditions
- One-dimensional mathematical examples for illustration
- FEM for heat transfer
- FEM for structural analysis
- FEM for seepage flow problems
- Practical examples with commercial software (e.g. ABAQUS)

Intended Learning Outcomes:
Upon completion of the module, students are able to understand the principal methods for numerical modeling with FEM for environmental applications and apply them to corresponding problems. In particular, they are able to:
- remember the principal steps of Finite Element Methods;
- understand the underlying assumptions and simplifications;
- apply the corresponding mathematical methods;
- apply the essential parts of the FEM theory;
- analyze problems in environmental engineering with respect to FEM modeling;
- evaluate corresponding literature;
- create solution strategies for heat transfer, structural mechanics, and seepage flow analysis.

Teaching and Learning Methods:
Lecture with presentations and discussions to explain the module content
Seminar with presentations and application exercises (analytical or software-based)
The content of the lectures will be exemplified by studies from environmental engineering and clarified by discussions with the students. In addition, the students will be motivated during the lectures to complement their studies with literature to initiate self-directed investigations in the field. In the seminar, particular examples will be studied related to precise problems from environmental engineering. Exercise sheets and further literature will be offered to deepen the knowledge and understanding.

Media:
PowerPoint, white board, exercise sheets, software examples (e.g. ABAQUS)

Reading List:
K.-J. Bathe: Finite-Elemente-Methoden. 2nd Edition, Springer, 2002.
R. W. Lewis: Fundamentals of the Finite Element Method for Heat and Fluid Flow. Wiley, 2004.

Responsible for Module:
Fabian Duddeck (duddeck@bv.tu-muenchen.de)

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

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

Technische Universität München

Module Description
BV380005: Process Water

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
Prüfungsdauer (in min.): 60.
schriftliche Prüfung

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none

Content:
Sustainable handling with water is the content of the lecture. The Drinking Water Ordinance is the basis for the evaluation of water with data analysis that are also shown. Water treatment as well as cleaning and desinfection are taught. Korrosion and practical examples are also part of the lecture.

Intended Learning Outcomes:
Students are able to estimate relevant water parameters to choose the adequate water treatment measures considering environmental and cost aspects.

Teaching and Learning Methods:
The lecture is supported by powerpoint. Examples are shown.

Media:
The lecture is supported by powerpoint. Examples are shown.

Reading List:
-

Responsible for Module:
Karl Glas (karl.glas@bfs.bayern.de)

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

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

Technische Universität München

Module Description

BV480003: Digital Image Processing [DBV]

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The written exam takes 60 minutes. Questions contain drawing and explaining figures, answering questions on methods and solutions, calculations or comparisons of methods and their applicability. Additionally, multiple-choice-questions are including with statements that have to be evaluated as true or false. This part does not contain more than 20% of the total points. No aids or materials are allowed.
Additionally, study projects have to be done containing programming and documenting solutions for practical problems. As programming and documentation quality cannot be checked in an examination, this part is done as study work. The study work is necessary to pass the module, but is not included in the module grade.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
" MatLab basics

Content:
" Introduction
" Features of digital images
" Image transformation
" Segmentation
" Binary image processing
" Vectorization and geometric primitives
" Feature extraction

Intended Learning Outcomes:
At the end of the module students are able to
" evaluate characteristic features of images,
" create and to apply different image transformations,
" analyze images by semenetation and feature extraction
" analyse binary images and to assess results
" compare image processing operations

Teaching and Learning Methods:
Lecture: Slides and lecture notes with small examples and discussion
Exercises: Small examples with programming in Matlab

Media:
Lecture: Slides, lecture notes, whiteboard
Exercises: Slides, exercise sheets, computer

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

Responsible for Module:
Uwe Stilla (stilla@tum.de)

Courses (Type of course, Weekly hours per semester), Instructor:
Labs in Digital Image Processing (exercise, 1 SWS)
Hoegner L, Hanel A

Digital Image Processing (lecture, 1 SWS)
Hoegner L [L], Stilla U

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

Technische Universität München

Module Description

BV500006: Soil Mechanics and Foundation Engineering - Supplementary Module [GB EM]

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
Proof of performance takes place in the form of a 90 minute written exam.
The exam divided into two parts:
The first approx. 20 minute part consists of general questions with unrestricted formulations. In this part no aids (only pens, set square, compass) are allowed. It will be proven, that the students have developed an understanding for the convayed fundamental soil mechanical relationships within the scope of the module. These include:
- Methods of subsoil improvements
- Earth pressure assumptions

The focus of the answers in this part lies on individual shorthand formulations. In part, small calculation problems must also be solved.
A second approx. 70 minute part consists of calculations and dimensioning tasks. As an aid all study documents, literature and a basic academic calculator are allowed. It will be proven, that students are capable of analysing and solving geotechnical calculations in a limited amount of time. This includes:
- Calculation of surface foundations
- Calculation of excavation enclosures

The answers in this part require extensive calculations. In part, short individual formulations are necessary.
The final grade is compsed of the respective time emphasis.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
The following modules should be passed: (Notice: The contents of the modules can be found in the respective module manuals (handbooks).)
- Foundation Engineering and Soil Mechanics Base Module (BV000019 or BV000108)
- Technical Mechanics I (BV000001)
- Technical Mechanics II (BV000004)
- Advanced Mathematics I (MA9517)
- Advanced Mathematics II (MA9512)

Content:
- Basic surface foundations
- Interaction structure - subsoil
- Subsoil improvements
- Deep foundations
- Earth pressure

- Excavation site enclosures
- Anchorage
- Soldier pile wall

Intended Learning Outcomes:
After participating in the module events the student is able to
- remember subsoil improvement measures
- understand earth pressure assumptions
- apply prooving methods for surface foundations
- carry out prooving methods for anchorages
- plan deep foundations
- design excavation enclosures

Teaching and Learning Methods:
The lecture is intensively assisted by a PowerPoint presentation, whereby the students can directly profit from the experience of the lecturer. In part, demonstration materials for a better illustration of the lecture facts will be handed out. Films concerning experiments and procedures are integrated, as well as an excursion to a reachable construction site. The contents of the lecture are deepened by exercise courses. During the exercises lecture notes to be completed by the students are used to deepen the topics of the lecture with calculation examples. For better understanding 5 term papers are handed out, which can be used for practice voluntarily outside of the attendance phase. Tutorials are offered by students to support the solving of the term papers.

Media:
lecture notes, exercise notes, PowerPoint-presentation, field trips, blackboard, demonstration lab tests, films

Reading List:
VOGT, N. lecture notes "Studienunterlagen Grundbau und Bodenmechanik"
KOLYMBAS, D. (1998): Geotechnik - Bodenmechanik und Grundbau; Springer-Verlag (Univ. Innsbruck)
LANG, HUDER, AMANN (2003): Bodenmechanik und Grundbau,Springer Verlag (ETH Zürich)
SCHMIDT, H.-H. (2001): Grundlagen der Geotechnik Verlag Teubner

Responsible for Module:
Akad. Dir. Dr.-Ing. Dirk Heyer, dirk.heyer@tum.de

Courses (Type of course, Weekly hours per semester), Instructor:
Fundamentals of Soil Mechanics and Foundation Engineering Supplementary Module (lecture with integrated exercises, 4 SWS)
Cudmani R, Wiendl A

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

Technische Universität München

Module Description

BV520011: Practice Issues in transportation

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The examination consists of two parts, each contributing 50% to the final grade.
A written examination tests whether the students are able to remember the contents of the presentations without auxiliaries and describe them in their own words. This will prove that they have basic knowledge in traffic engineering.
Based on the meetings, the students will furthermore turn in a fictitious application as an environmental engineer aiming to work in mobility/traffic planning. Cover letter and CV have to be turned in on the day of the exam. This ensures that the students have understood what competences are required and that they are able to apply this knowledge to develop goals for their own working career. This makes up an important part of determining the students¿ own professional profile.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Interest in transportation.
Basic knowledge about transportation.
Study program Environmental Engineering.

Content:
The students will gain insight into the working life of prospective environmental engineers by visiting potential employers in the region. An overview of potential working fields is given. The following contents may vary depending on the visited institutions:
- traffic and mobility management
- road construction and maintenance
- urban infrastructure planning
- sustainable urban development
- environmental precautions
- monitoring of air quality
- noise protection
- environmental consulting
- environmental and landscape planning
- eco-audit
- renewables
- new driving technologies and material

Intended Learning Outcomes:
Upon completion of the course, students are able to:
- remember basic contents of their potential future everyday business
- understand what is required of an environmental engineer and what is needed to start a successful career
- discover personal interests and potentially the main focus of their own working career
- develop an individual profile, analyze their professional knowledge and present it in a convincing way

Teaching and Learning Methods:
Several speakers present their everyday business. The students will get an overview of an environmental engineer¿s focus areas. In order to get a better impression of the respective occupation, the presentations may take place in the speaker¿s usual working environment. The contents are discussed with the students afterwards so that they gain a better understanding of the profession¿s main tasks.

Media:
Presentations

Reading List:
Pitterle, Susanne (2010): Mobilität in Deutschland (MiD). Alltagsverkehr in München, im Münchner Umland und im MVV-Verbundraum. Landeshauptstadt München, Referat für Stadtplanung und Bauordnung.
Regierung von Oberbayern (2004): Luftreinhalteplan für die Stadt München. Bayerisches Staatsministerium für Umwelt, Gesundheit und Verbraucherschutz.
Sassen, Wigand von (2014): Münchner Radlszene. Alles rund um¿s Rad. Landeshauptstadt München, Kreisverwaltungsreferat.
Zorn, Elisabeth (2010): Radverkehr in München. Landeshauptstadt München, Referat für Stadtplanung und Bauordnung.

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

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

Kinigadner, Julia, julia.kinigadner@tum.de
Benjamin Büttner, benjamin.buettner.@tum.de
Montserrat Miramontes Montserrat.miramontes@tum.de

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

Technische Universität München

Module Description

BV600011: Engineering Data Analysis with Matlab [DAM]

Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Bachelor	English	one semester	summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
2	60	40	20

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

Description of Examination Method:
Project work: The students will work in small groups on a 6 week project, where they will apply the methods learned during the course. The problem the students will have to solve is closely related to the exercises given throughout the semester. It will involve mainly basic statistical data analysis based on the software tool Matlab. The students will have to organize the team and hereby practice and apply soft skills required for team work. The project must result in a Matlab code and a written report which is graded.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Basic knowledge of probability concepts such as random variables and their description (e.g., through completion of the BSc course Zuverlässigkeit und Lastannahmen or Einführung in das Risikomanagement) is of advantage, but not required.

Content:
This course is designed to make students familiar with Matlab and its application for the analysis of data.
1. Statistics of data sets
2. Graphical representation of data sets
3. Statistics of pairs of data sets
4. Simulation of random variables

Intended Learning Outcomes:
This course is designed to make students familiar with Matlab and its application for the analysis of data. At the end of the course, students will be able to:
- Perform data analysis (statistics) using Matlab
- Interpret the information hidden in data sets
- Simulate random variables using Matlab

Teaching and Learning Methods:
The course will consist of 4 weeks of weekly lectures (2 hours) and exercises (2 hours). The lectures will be given with PowerPoint presentations and examples will be shown in Matlab. The students will subsequently solve practical exercises in Matlab together with the help of supervising tutors. The lecture notes in PDF form will be distributed at the beginning of the semester.

Media:
- lectures with Powerpoint presentations
- excercises using Matlab supervised by tutors
- lecture notes including theory and examples

Reading List:
Lecture notes will be distributed. The following books provide useful supplemental material:

- Ang, A. H.-S., and Tang, W. H. (2006). Probability Concepts in Engineering: Emphasis on Applications to Civil and Environmental Engineering, Wiley, New York.
- http://www.mathworks.de/help/techdoc/

Responsible for Module:
Daniel Straub (straub@tum.de)

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

Anke Scherb
anke.scherb@tum.de

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

Technische Universität München

Module Description

CH1121: Laboratory Course in Chemistry

Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
4			

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

Description of Examination Method:

Repeat Examination:

(Recommended) Prerequisites:

Content:

Intended Learning Outcomes:

Teaching and Learning Methods:

Media:

Reading List:

Responsible for Module:

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

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

Technische Universität München

Module Description

MA9515: Numerical Mathematics 2 BGU

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The module examination is based on a written exam (60 minutes). Students have to know advanced concepts of Numerical Mathematics and are familiar with the calculus in these cases. They show their ability to deal with mathematical problems of structural and surveying engineering in limited time.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
MA9501 - Advanced Mathematics 1
MA9502 - Advanced Mathematics 2
MA9511 - Applied Mathematics BGU

Content:
Initial value problems of ordinary differential equations: explicit and implicit one-step methods, multi-step methods; boundary value problems of ordinary differential equations: shooting method, finite difference method; partial differential equations: well-posed problems, finite difference method; computation of eigenvalues: Sturm-Liouville eigenvalue problem, vector iteration, inverse vector iteration, QR iteration.

Intended Learning Outcomes:
After successful completion of the modul, students are able to understand and apply the content covered.

Teaching and Learning Methods:
lecture, exercise session

Media:
blackboard

Reading List:
Matthias Bollhöfer, Volker Mehrmann: Numerische Mathematik. Eine projektorientierte Einführung für Ingenieure, Mathematiker und Naturwissenschaftler, Vieweg Verlag, Wiesbaden, 2004.

Responsible for Module:
Johann, Andreas; PD Dr. rer. nat.

Courses (Type of course, Weekly hours per semester), Instructor:
Numerical Methods (BGU) (lecture, 3 SWS)
Pfefferer J

Numerical Methods (BGU) (Exercise Session) (exercise, 1 SWS)
Pfefferer J

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

Technische Universität München

Module Description

SZ0488: English - Gateway to English Master's C1

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
Grades for an oral presentation (including a handout and visual aids 25%), multiple drafts of two homework assignments to allow students to develop written skills by means of a process of drafting and revising texts (50% total), and a final written examination (25%) contribute to the final course grade. Duration of the final examination: 60 minutes.

Repeat Examination:

(Recommended) Prerequisites:
C1 level according to the online placement test

Content:
This course includes note-taking in lectures, practising tutorial participation, academic writing and presenting a topic on a related field of study focusing on skills such as avoiding plagiarism, ethics, and formulating research questions.

Intended Learning Outcomes:
Upon finishing this course you will be able to follow lectures in English with little difficulty and summarize the main ideas. You will be sufficiently comfortable with English as to be able to write longer papers and critical essays in English, making use of general argumentation and rhetorical conventions.

Teaching and Learning Methods:
This course involves practising study situations (participating in seminars, tutorials, note-taking in lectures), pair-work & group-work in an English-speaking academic environment.

Media:
Internet, handouts, online material

Reading List:
n/a

Responsible for Module:
Heidi Minning

Courses (Type of course, Weekly hours per semester), Instructor:
English - Controversial Topics in Science and Technology: Gateway to English Master's C1 (seminar, 2 SWS)
Balton-Stier J, Starck S

English - English for Civil Engineering: Gateway to English Master's C1 (seminar, 2 SWS)
Clark R

English - English for Environmental Engineering: Gateway to English Master's C1 (seminar, 2 SWS)
Clark R

English - Englisch - English for Geodesy: Gateway to English Master¿s C1 (seminar, 2 SWS)
Clark R

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

Technische Universität München

Module Description
WI000202: Environmental Policy

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The module examination consists of a written exam (60 minutes). The learning outcomes are examined by various questions including questions regarding student¿s knowledge, questions that require a transfer of forest policy questions to other policy areas and questions to check the capacity to establish mental connections between separate fields of politics and theoretical approaches.

By answering the questions, students also show that they are able to
- communicate and explain the basic expressions
- show that they can apply theoretical approaches with regard to forest policy questions
- transfer forest policy questions to other policy areas
- clarify that they can differentiate between the different perspectives of forest and environmental policy.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
none - an interest in questions pertaining to the environmental policy field

Content:
With a sound theoretical basis the structure, prozesse and content of environmental policy will be conveyed. Using case studies, the theoretical and mehtodical approached will be clarified.
The follwoing policy areas are made subject of the course:
Policy about allowed substances in water (nitrate, pesticides, drugs)
Policy about contaminated air (ozon, particulate matter, sulfur compounds)
Policy about climate change
International policy (Agreements, policy guidelines)

Intended Learning Outcomes:
At the end of the module, students are able to recognize complex sociological problems in the field of forest and environmental policy and to analyse and propose solutions for policy conflicts.
The students obtain the competence to:
- recognize questions pertaining to forest and environmental policy
- recognize different position of stakeholders
- apply policy theories to the specific policy area of forest and environmental policy

Teaching and Learning Methods:
the following teaching/learning methods will be used:
a) lecture
b) planning games (role-playing games)
c) group work

Media:
PowerPoint, videos, posters, texts and presentations

Reading List:
Prittwitz, V.v. 1990: Das Katastrophenparadox Elemente einer Theorie der Umweltpolitik, Leske+ Budrich.
Aden, H. 2012: Umweltpolitik, Lehrbuch, Elemente der Politik, VS Verlag für Sozialwissenschaften.

Responsible for Module:
Suda, Michael; Prof. Dr. rer. silv.

Courses (Type of course, Weekly hours per semester), Instructor:
Environmental Policy (WI000202) (lecture, 2 SWS)
Suda M

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

Technische Universität München

Module Description

WI000728: Foundations of Business Administration 1

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The grading is based on a written exam (60 minutes). Students have to show whether they can remember, distinguish and evaluate the organizational forms of enterprises, financing instruments, methods of capital budgeting, corporate valuation procedures, methods and requirements of internal and external accounting and human resources. The answers in the written exam require own wording as well as answering mulitiple choice questions. As the content of this modul includes the imparting of basic knowledge in business economics, the workload for students covers 3 ECTS.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
None

Content:
Organizational forms of enterprises - financing instruments (equity financing, internal and external financing) - methods of capital budgeting (cost analysis, net present value analysis, internal rate of return analysis) - corporate valuation procedures (discounted cash flow analysis, multiple valuation) - methods and requirements of internal and external accounting (national and international accounting standards, origin and allocation of costs) - human resource management (forms of organizing, history of organizational research, human resource thories, motivational theories)

Intended Learning Outcomes:
Upon successful completion of this module, students will be able to remember, distinguish and evaluate the organizational forms of enterprises, financing instruments, methods of capital budgeting, corporate valuation procedures, methods and requirements of internal and external accounting as well as human resources. More specifically,students will learn to differentiate several forms of organizing and to analyze organizational structures in order to find appropriate ways of organizing. Further they understand principal agent relationships, the consequences of information asymmetries and are able to determine the optimal boundaries of organizations. They further understand the cycle of human resource management as well as personal development. Moreover, students will learn to decide on whether investments are profitable and how to determine the value of a firm. This is helpful when buying or selling stocks or creating a business plan. Students also will learn to distinguish between the instruments of external accounting and to differentiate between national and international accounting standards. Regarding internal accounting, they will understand the origin and allocation of costs.

Teaching and Learning Methods:
The module is designed in the form of a lecture, on which the theoretical contents are taught. Moreover, individual

aspects and applications will be discussed with the students by asking open-ended questions. Thus they learn to distinguish the subjects from each other and are able to evaluate the methods with regard to their use in each case.

Media:

Use of presentation slides (PowerPoint). The presentation slides include theoretical content and questions that additionally stimulate the understanding of the contents. Furthermore, arithmetic problems or application examples are included. The module will be recorded and can be downloaded in retrospect through www.lecturio.de. The script for the module will be made available online.

Reading List:

Thommen, J., Achleitner, A.-K.: Allgemeine Betriebswirtschaftslehre, Gabler, 7., vollst. überarb. Auflage, Wiesbaden 2012.
Thommen, J., Achleitner, A.-K.: Allgemeine Betriebswirtsschaftlehre - Arbeitsbuch, Gabler, 6., vollst. Überarb. Auflage, Wiesbaden 2009.
Vahs, D., Schäfer-Kunz, J.: Einführung in die Betriebswirtschaftslehre, Schäffer-Poeschel, 5. Auflage, 2007.
Schmalen, H., Pechtl, H.: Grundlagen und Probleme der Betriebswirtschaft, Schäffer-Poeschel, 14. Auflage, 2009.

Responsible for Module:

Friedl, Gunther; Prof. Dr.

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

Betriebswirtschaftslehre 1 - Grundlagen (Nebenfach)(Vorlesung), 2 SWS
Gunther Friedl, Prof. Dr. (gunther.friedl@tum.de) Ann-Kristin Achleitner, Prof. Dr. Dr. (ann-kristin.achleitner@wi.tum.de)
Christoph Kaserer, Prof. Dr. (christoph.kaserer@tum.de)
Isabell Welpe Prof. Dr. (isabell.welpe@tum.de)

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

Technische Universität München

Module Description

WI000729: Foundations of Business Administration 2

Civil, Geo and Environmental Engineering

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

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

Description of Examination Method:
The grading is based on a written exam (60 minutes). The questions in the written exam asses the learning outcomes. By answering multiple choice questions students have to show that they can remember, distinguish and evaluate the content of the lectures in innovation management, marketing, logistics, and production management.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Fundamentals in business administration 1 (minor)

Content:
This lecture covers the fundamentals of

Innovation management (Prof. Henkel)
-Strategy
-Innovation: Markets
-Innovation: Organisation

Marketing (Prof. Königstorfer)
-Fundamentals of marketing
-Market segmentation
-Brand management

Logistics (Prof. Minner)
- General definitions
-Stock-keeping
-Transportation logistics

Production management (Prof. Grunow)
-Strategic planning of production networks
-Design of production systems
-Production scheduling

Intended Learning Outcomes:
Upon successful completion of this module, students will be able to remember, distinguish and evaluate topics in innovation management, marketing, logistics, and production management.

Teaching and Learning Methods:
The module is designed in the form of a lecture, on which the theoretical contents are taught. Moreover, individual aspects and applications will be discussed with the students by asking open-ended questions. Thus they learn to distinguish the subjects from each other and are able to evaluate the methods with regard to their use in each case.

Media:
Use of presentation slides (PowerPoint). The presentation slides include theoretical content and questions that additionally stimulate the understanding of the contents.

Reading List:

Responsible for Module:
Henkel, Joachim; Prof. Dr. rer. pol.

Courses (Type of course, Weekly hours per semester), Instructor:
Foundations of Business Administration 2 (WI000729): (lecture, 2 SWS)
Minner S (Svoboda J), Grunow M, Henkel J, Königstorfer J

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

Technische Universität München

Module Description

WI001042: Environmental Policy II

Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Bachelor	German	one semester	summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
3	90	50	40

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

Description of Examination Method:
Writing of a scientific report (4 pages) about a specfic question of the project (press release, final report)
Participation in the project (taking part in discussions, developing the system of categories, development of poster presentations, press conference)
Conducting the survey

The learning outcomes will be tested in two different formats. The written report, in which the students should able to condense the found results while complying with scientific standards.The press conference and press release show how students are able to interpret scientific results and insert them into political communication. Within the framework of the poster presentations, students whold be able to show their ability to outline scientific results and present them.

Repeat Examination:
Next semester

(Recommended) Prerequisites:
Environemental Policy lecture

Content:
In the framework of policy analysis the example of the energy revolution will looked at and theoretical knowledge from the lecture environmental policy will be deepend. An introduction to the methods of the empirical social research should strengthen the critical thinking towards surveys. The conduction of the survey, the development of a system of categories and the presentation and interpretation of the results are the basis for scientific work.

Introduction to project management
Introduction to methods of the empirical social research
Possibilities and limits of surveys
Development of a project plan
Development of a survey on the basis of already existing survey with critical extra questions
Conduction of a survey (sample with a ratio for age, sex and city district)
statistical evaluation
interpretation of the results
presentaiton of results (poster)
press release (press conference)
writing of the final report

Intended Learning Outcomes:
Project management (learning the basics, gathering experiences)
Surveys (critical assessment, assessing the limits and gathering experiences in action)
Statistics (learning the basics, assessing the limits, using simple procedures)
Utilisation of results (poster and press release, final report, defending the results in a critical discussion)
Research process (critical reflection of the whole process)

Teaching and Learning Methods:
lecture
group work
presentation
role-playing games

Media:
Report, Press release, poster, presentation

Reading List:
You have to be informed about the topic ¿Politik der Energiewende¿ (Grundlage für Blockwoche)
S. Blum, K. Schubert (2011) Politikfeldanalyse. Lehrbuch. VS Verlag -> Kap. 1, Kap. 2.2 (ab S. 26), Kap. 4 (S. 54-72, 72-103)
Suda, Michael; Dobler, Günter (2015): Die Nationalparkdiskussion in Deutschland ¿ Wie lässt sich mit Umfragen manipulieren? In: Jahrbuch der Baumpflege 2015, S. 19-33

Responsible for Module:
Suda, Michael; Prof. Dr. rer. silv.

Courses (Type of course, Weekly hours per semester), Instructor:
Umweltpolitik II - Politikfeldanalyse

Prof. Dr. Michael Suda

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

Technische Universität München

Bachelor´s Thesis

Technische Universität München

Module Description
BV000400: Bachelor´s Thesis

Civil, Geo and Environmental Engineering

Module Level:	Language:	Duration:	Frequency:
Bachelor	German/English	one semester	winter/summer semester
Credits:*	**Total Hours:**	**Self-study Hours:**	**Contact Hours:**
9	270	270	

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 Bachelor's Thesis: The student proofs ability to individually solve a partial problem within the field of the Bachelor's Degree by creating individual concepts and conducting hands-on research (100% of module grade).
- Final presentation: With the final presentation the student proofs the ability to present methods and results in a structured way (pass/fail credit requirement, has to be passed)

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 from the department of their studies that deals with a problem within the field of the Bachelor's Degree.

Intended Learning Outcomes:
After successful completion of the module, students are able to participate in the solving of a scientific problem within the field of the Bachelor's Degree or categorize a problem within existing theories. They are able to identify and apply suitable methods to the problem out of the methods learned during studies as well as relevant literature. The abilities include presentation of results with both supervisor and interested audience, 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 Bachelor's Thesis has the format of a project work that not only contains manual task and calculations, but also planning and conceptual elements that are part of the work scope in professional engineering life.

Every participant works on an individual technical task, in an independent way.
Every participant is assingned a scientific advisor matching the topic. The advisor assists especially during the early stage of the work, presenting the thechnical background of the topic, preparing relevant literature and by giving helpful methodological hints both during the technical work and during the creation of the written documentation and presentation.

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.