TUHH
Hamburg
University of
Technology

Module Manual

Bachelor of Science (B.Sc.)

Civil- and Environmental Engineering

Cohort: Winter Term 2023

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Table of Contents

Program description

Content

Program structure

Core Qualification

Module M0687: Chemistry

Courses

Title	Typ	Hrs/wk	CP
Chemistry I+II (L0460)	Lecture	4	4
Chemistry I+II (L0475)	Recitation Section (large)	2	2

Module Responsible	Dr. Dorothea Rechtenbach
Admission Requirements	None
Recommended Previous Knowledge	none
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are able to name and to describe basic principles and applications of general chemistry (structure of matter, periodic table, chemical bonds), physical chemistry (aggregate states, separating processes, thermodynamics, kinetics), inorganic chemistry (acid/base, pH-value, salts, solubility, redox, metals) and organic chemistry (aliphatic hydrocarbons, functional groups, carbonyl compounds, aromates, reaction mechanisms, natural products, synthetic polymers). Furthermore students are able to explain basic chemical terms.
Skills	After successful completion of this module students are able to describe substance groups and chemical compounds. On this basis, they are capable of explaining, choosing and applying specific methods and various reaction mechanisms.
Personal Competence	
Social Competence	Students are able to take part in discussions on chemical issues and problems as a member of an interdisciplinary team. They can contribute to those discussion by their own statements.
Autonomy	After successful completion of this module students are able to solve chemical problems independently by defending proposed approaches with arguments. They can also document their approaches.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Core Qualification: Compulsory Civil- and Environmental Engineering: Core Qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0460: Chemistry I+II	
Typ	Lecture
Hrs/wk	4
CP	4
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
Lecturer	Dr. Christoph Wutz
Language	DE
Cycle	WiSe
Content	Chemistry I: - Structure of matter - Periodic table - Electronegativity - Chemical bonds - Solid compounds and solutions - Chemistry of water - Chemical reactions and equilibria - Acid-base reactions - Redox reactions Chemistry II: - Simple compounds of carbon, aliphatic hydrocarbons, aromatic hydrocarbons, - Alkohols, phenols, ether, aldehydes, ketones, carbonic acids, ester, amines, amino acids, fats, sugars - Reaction mechanisms, radical reactions, nucleophilic substitution, elimination reactions, addition reaction - Practical apllications and examples
Literature	- Blumenthal, Linke, Vieth: Chemie - Grundwissen für Ingenieure - Kickelbick: Chemie für Ingenieure (Pearson) - Mortimer: Chemie. Basiswissen der Chemie. - Brown, LeMay, Bursten: Chemie. Studieren kompakt. - Schmuck: Basisbuch Organische Chemie (Pearson)

Course L0475: Chemistry I+II	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Dorothea Rechtenbach
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0850: Mathematics I

Courses

Title	Typ	Hrs/wk	CP
Mathematics I (L2970)	Lecture	4	4
Mathematics I (L2971)	Recitation Section (large)	2	2
Mathematics I (L2972)	Recitation Section (small)	2	2

Module Responsible	Prof. Anusch Taraz
Admission Requirements	None
Recommended Previous Knowledge	School mathematics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students can name the basic concepts in analysis and linear algebra. They are able to explain them using appropriate examples. • Students can discuss logical connections between these concepts. They are capable of illustrating these connections with the help of examples. • They know proof strategies and can reproduce them.
Skills	• Students can model problems in analysis and linear algebra with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods. • Students are able to discover and verify further logical connections between the concepts studied in the course. • For a given problem, the students can develop and execute a suitable approach, and are able to critically evaluate the results.
Personal Competence	
Social Competence	• Students are able to work together in teams. They are capable to use mathematics as a common language. • In doing so, they can communicate new concepts according to the needs of their cooperating partners. Moreover, they can design examples to check and deepen the understanding of their peers.
Autonomy	• Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them. • Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard problems.
Workload in Hours	Independent Study Time 128, Study Time in Lecture 112
Credit points	8
Course achievement	Compulsory: Yes; Bonus: 10 %; Form: Excercises; Description:
Examination	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Core Qualification: Compulsory Civil- and Environmental Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Core Qualification: Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory Computer Science in Engineering: Core Qualification: Compulsory Integrated Building Technology: Core Qualification: Compulsory Logistics and Mobility: Core Qualification: Compulsory Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Orientation Studies: Core Qualification: Elective Compulsory Naval Architecture: Core Qualification: Compulsory Process Engineering: Core Qualification: Compulsory Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory

Course L2970: Mathematics I	
Typ	Lecture
Hrs/wk	4
CP	4
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
Lecturer	Prof. Anusch Taraz
Language	DE
Cycle	WiSe
Content	Mathematical Foundations: sets, statements, induction, mappings, trigonometry Analysis: Foundations of differential calculus in one variable • natural and real numbers • convergence of sequences and series • continuous and differentiable functions • mean value theorems • Taylor series • calculus • error analysis • fixpoint iteration Linear Algebra: Foundations of linear algebra in R^n • vectors: rules, linear combinations, inner and cross product, lines and planes • systems of linear equations: Gauß elimination, linear mappings, matrix multiplication, inverse matrices, determinants • orthogonal projection in R^n, Gram-Schmidt-Orthonormalization
Literature	• T. Arens u.a. : Mathematik, Springer Spektrum, Heidelberg 2015 • W. Mackens, H. Voß: Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994 • W. Mackens, H. Voß: Aufgaben und Lösungen zur Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994 • G. Strang: Lineare Algebra, Springer-Verlag, 2003 • G. und S. Teschl: Mathematik für Informatiker, Band 1, Springer-Verlag, 2013

Course L2971: Mathematics I	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Anusch Taraz, Dr. Dennis Clemens, Dr. Simon Campese
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L2972: Mathematics I	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Anusch Taraz
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0577: Non-technical Courses for Bachelors

Module Responsible	Dagmar Richter
Admission Requirements	None
Recommended Previous Knowledge	None
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	**The Non-technical Academic Programms (NTA)** imparts skills that, in view of the TUHH's training profile, professional engineering studies require but are not able to cover fully. Self-reliance, self-management, collaboration and professional and personnel management competences. The department implements these training objectives in its **teaching architecture**, in its **teaching and learning arrangements**, in **teaching areas** and by means of teaching offerings in which students can qualify by opting for **specific competences** and a **competence level** at the Bachelor's or Master's level. The teaching offerings are pooled in two different catalogues for nontechnical complementary courses. **The Learning Architecture** consists of a cross-disciplinarily study offering. The centrally designed teaching offering ensures that courses in the nontechnical academic programms follow the specific profiling of TUHH degree courses. The learning architecture demands and trains independent educational planning as regards the individual development of competences. It also provides orientation knowledge in the form of "profiles" The subjects that can be studied in parallel throughout the student's entire study program - if need be, it can be studied in one to two semesters. In view of the adaptation problems that individuals commonly face in their first semesters after making the transition from school to university and in order to encourage individually planned semesters abroad, there is no obligation to study these subjects in one or two specific semesters during the course of studies. **Teaching and Learning Arrangements** provide for students, separated into B.Sc. and M.Sc., to learn with and from each other across semesters. The challenge of dealing with interdisciplinarity and a variety of stages of learning in courses are part of the learning architecture and are deliberately encouraged in specific courses. **Fields of Teaching** are based on research findings from the academic disciplines cultural studies, social studies, arts, historical studies, migration studies, communication studies and sustainability research, and from engineering didactics. In addition, from the winter semester 2014/15 students on all Bachelor's courses will have the opportunity to learn about business management and start-ups in a goal-oriented way. The fields of teaching are augmented by soft skills offers and a foreign language offer. Here, the focus is on encouraging goal-oriented communication skills, e.g. the skills required by outgoing engineers in international and intercultural situations. **The Competence Level** of the courses offered in this area is different as regards the basic training objective in the Bachelor's and Master's fields. These differences are reflected in the practical examples used, in content topics that refer to different professional application contexts, and in the higher scientific and theoretical level of abstraction in the B.Sc. This is also reflected in the different quality of soft skills, which relate to the different team positions and different group leadership functions of Bachelor's and Master's graduates in their future working life. **Specialized Competence (Knowledge)** Students can • locate selected specialized areas with the relevant non-technical mother discipline, • outline basic theories, categories, terminology, models, concepts or artistic techniques in the disciplines represented in the learning area, • different specialist disciplines relate to their own discipline and differentiate it as well as make connections, • sketch the basic outlines of how scientific disciplines, paradigms, models, instruments, methods and forms of representation in the specialized sciences are subject to individual and socio-cultural interpretation and historicity, • Can communicate in a foreign language in a manner appropriate to the subject.
Skills	**Professional Competence (Skills)** In selected sub-areas students can • apply basic methods of the said scientific disciplines, • auestion a specific technical phenomena, models, theories from the viewpoint of another, aforementioned specialist discipline, • to handle simple questions in aforementioned scientific disciplines in a sucsessful manner, • justify their decisions on forms of organization and application in practical questions in contexts that go beyond the technical relationship to the subject.
Personal Competence	
Social Competence	**Personal Competences (Social Skills)** Students will be able • to learn to collaborate in different manner,

	• to present and analyze problems in the abovementioned fields in a partner or group situation in a manner appropriate to the addressees, • to express themselves competently, in a culturally appropriate and gender-sensitive manner in the language of the country (as far as this study-focus would be chosen), • to explain nontechnical items to auditorium with technical background knowledge.
Autonomy	**Personal Competences (Self-reliance)** Students are able in selected areas • to reflect on their own profession and professionalism in the context of real-life fields of application • to organize themselves and their own learning processes • to reflect and decide questions in front of a broad education background • to communicate a nontechnical item in a competent way in writen form or verbaly • to organize themselves as an entrepreneurial subject country (as far as this study-focus would be chosen)
Workload in Hours	Depends on choice of courses
Credit points	6

Courses
Information regarding lectures and courses can be found in the corresponding module handbook published separately.

Module M0580: Principles of Building Materials and Building Physics

Courses

Title	Typ	Hrs/wk	CP
Building Physics (L0217)	Lecture	2	2
Building Physics (L0219)	Recitation Section (large)	1	1
Building Physics (L0247)	Recitation Section (small)	1	1
Principles of Building Materials (L0215)	Lecture	2	2

Module Responsible	Prof. Frank Schmidt-Döhl
Admission Requirements	None
Recommended Previous Knowledge	Knowledge of physics, chemistry and mathematics from school
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are able to identify fundamental effects of action to materials and structures, to explain different types of mechanical behaviour, to describe the structure of building materials and the correlations between structure and other properties, to show methods of joining and of corrosion processes and to describe the most important regularities and properties of building materials and structures and their measurement in the field of protection against moisture, coldness, fire and noise.
Skills	The students are able to work with the most important standardized methods and regularities in the field of moisture protection, the German regulation for energy saving, fire protection and noise protection in the case of a small building.
Personal Competence	
Social Competence	The students are able to support each other to learn the very extensive specialist knowledge.
Autonomy	The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	2 h written exam
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Core Qualification: Compulsory Integrated Building Technology: Core Qualification: Compulsory Orientation Studies: Core Qualification: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0217: Building Physics

Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	WiSe
Content	Heat transport, thermal bridges, balances of energy consumption, German regulation for energy saving, heat protection in summer, moisture transport, condensation moisture, protection against mold, fire protection, noise protection
Literature	Fischer, H.-M. ; Freymuth, H.; Häupl, P.; Homann, M.; Jenisch, R.; Richter, E.; Stohrer, M.: Lehrbuch der Bauphysik. Vieweg und Teubner Verlag, Wiesbaden, ISBN 978-3-519-55014-3

Course L0219: Building Physics

Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0247: Building Physics	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0215: Principles of Building Materials	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	WiSe
Content	Structure of building materials Effects of action Fundamentals of mechanical behaviour Material testing Principles of metals Joining methods
Literature	Wendehorst, R.: Baustoffkunde. ISBN 3-8351-0132-3 Scholz, W.:Baustoffkenntnis. ISBN 3-8041-4197-8

Module M1802: Engineering Mechanics I (Stereostatics)

Courses

Title	Typ	Hrs/wk	CP
Engineering Mechanics I (Statics) (L1001)	Lecture	2	3
Engineering Mechanics I (Statics) (L1003)	Recitation Section (large)	1	1
Engineering Mechanics I (Statics) (L1002)	Recitation Section (small)	2	2

Module Responsible	Prof. Benedikt Kriegesmann
Admission Requirements	None
Recommended Previous Knowledge	Solid school knowledge in mathematics and physics.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can • describe the axiomatic procedure used in mechanical contexts; • explain important steps in model design; • present technical knowledge in stereostatics.
Skills	The students can • explain the important elements of mathematical / mechanical analysis and model formation, and apply it to the context of their own problems; • apply basic statical methods to engineering problems; • estimate the reach and boundaries of statical methods and extend them to be applicable to wider problem sets.
Personal Competence	
Social Competence	The students can work in groups and support each other to overcome difficulties.
Autonomy	Students are capable of determining their own strengths and weaknesses and to organize their time and learning based on those.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Core Qualification: Compulsory Civil- and Environmental Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Core Qualification: Compulsory Data Science: Specialisation II. Application: Elective Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory Computer Science in Engineering: Specialisation II. Mathematics & Engineering Science: Elective Compulsory Integrated Building Technology: Core Qualification: Compulsory Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Orientation Studies: Core Qualification: Elective Compulsory Naval Architecture: Core Qualification: Compulsory Process Engineering: Core Qualification: Compulsory Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory

Course L1001: Engineering Mechanics I (Statics)	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Benedikt Kriegesmann
Language	DE
Cycle	WiSe
Content	• Tasks in Mechanics • Modelling and model elements • Vector calculus for forces and torques • Forces and equilibrium in space • Constraints and reactions, characterization of constraint systems • Planar and spatial truss structures • Internal forces and moments for beams and frames • Center of mass, volumn, area and line • Computation of center of mass by intergals, joint bodies • Friction (sliding and sticking) • Friction of ropes
Literature	**K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009).** **D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 1. 11. Auflage, Springer (2011).**

Course L1003: Engineering Mechanics I (Statics)	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Benedikt Kriegesmann
Language	DE
Cycle	WiSe
Content	Forces and equilibrium Constraints and reactions Frames Center of mass Friction Internal forces and moments for beams
Literature	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009). D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 1. 11. Auflage, Springer (2011).

Course L1002: Engineering Mechanics I (Statics)	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Benedikt Kriegesmann
Language	DE
Cycle	WiSe
Content	Forces and equilibrium Constraints and reactions Frames Center of mass Friction Internal forces and moments for beams
Literature	K. Magnus, H.H. Müller-Slany: Grundlagen der Technischen Mechanik. 7. Auflage, Teubner (2009). D. Gross, W. Hauger, J. Schröder, W. Wall: Technische Mechanik 1. 11. Auflage, Springer (2011).

Module M1631: Engineering Informatics

Courses

Title	Typ	Hrs/wk	CP
Databases (L2758)	Integrated Lecture	1	1
Databases (L2759)	Recitation Section (small)	1	1
Object-oriented Modelling (L2468)	Integrated Lecture	2	2
Object-oriented Modelling (L2469)	Recitation Section (small)	2	2

Module Responsible	Prof. Kay Smarsly
Admission Requirements	None
Recommended Previous Knowledge	Students can describe and analyze existing software programs in the discipline based on their essential characteristics. The students are able to reproduce the elementary basics and theoretical concepts of engineering informatics and to apply elementary solution algorithms to engineering problems. They are also able to define database principles and make simple queries to common database systems.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence *Knowledge* *Skills* **Personal Competence** *Social Competence* *Autonomy*	Fundamentals of (i) object-oriented modeling and (ii) database design will be presented. The students will be able to develop and to modify software as well as database systems required in the area of civil and environmental engineering. In part (i), the students will become familiar with fundamentals of engineering informatics programming methodologies, objects and classes, methods, functions, and procedures, UML notation (such as association, aggregation and composition), control structures, exception handling, data streams, inheritance, abstract classes and interfaces, data structures (e.g. associative memory with particular emphasis on hash tables and tree structures), algorithms and generic programming. Part (ii) follows the database design process and primarily covers conceptual design and semantics of database models (with emphasis on the Entity-Relationship Model), logical design (including integrity constraints, anomalies and normalization), relational algebra, relational query languages and SQL, database views, physical database design and implementation, concepts of database application development (JDBC) as well as data integration and data exchange in civil engineering.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	**Compulsory** / **Bonus** / **Form** / **Description** Yes / 15 % / Written elaboration / Als Prüfungsvorleistung wird ein schriftlicher Beleg angefertigt. Der Beleg umfasst die bis dahin bekannten Lehrinhalte und dient u.a. dazu, die Studierenden auf die Klausur vorzubereiten.
Examination	Written exam
Examination duration and scale	180 min
Assignment for the Following Curricula	Civil- and Environmental Engineering: Core Qualification: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory

Course L2758: Databases	
Typ	Integrated Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Kay Smarsly
Language	DE
Cycle	WiSe

Content	• Motivation and basic concepts
	• Terminology and definitions
	• Database design process
	• Conceptual design
	  ◦ Semantics of database models
	  ◦ The Entity-Relationship Model
	  ◦ Relationships in the ER model
	  ◦ Other concepts in the ER model
	  ◦ Conceptual modeling with UML
	• Logical design
	  ◦ The relational model
	  ◦ Integrity constraints
	  ◦ Anomalies and normalization
	  ◦ ER mapping to the relational model
	  ◦ Relational algebra
	• Relational query languages
	  ◦ Schema definition and modification
	  ◦ SQL as a relational query language
	  ◦ Modification options in SQL
	  ◦ Database views
	• Physical database design and implementation
	• Concepts of database application development
	• JDBC
	• Data integration and data exchange in civil engineering

Literature	

Course L2759: Databases	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Kay Smarsly
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L2468: Object-oriented Modelling	
Typ	Integrated Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kay Smarsly
Language	DE
Cycle	WiSe
Content	• Fundamentals of engineering informatics • Programming languages and programming paradigms • Programming methodology • Objects and classes • Constructors • Packages and imports • Visibility and validity • Methods, functions, and procedures • Variables and constants • UML notation • Control structures • Expressions and statements • Recursion • Exception handling • Inputs and outputs • Data streams • Association, aggregation and composition • Inheritance • Abstract classes and methods • Interfaces • Data structures and algorithms (e.g. arrays) • Generic programming • Lists, queues, and sets • Associative memory (particular emphasis on hash tables and tree structures) Further notes on algorithms
Literature	

Course L2469: Object-oriented Modelling	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kay Smarsly
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0590: Building Materials and Building Chemistry

Courses

Title	Typ	Hrs/wk	CP
Building Materials and Building Chemistry (L0248)	Lecture	4	4
Building Materials and Building Chemistry (L0249)	Recitation Section (small)	1	2

Module Responsible	Prof. Frank Schmidt-Döhl
Admission Requirements	None
Recommended Previous Knowledge	Module Principles of Building Materials and Building Physics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are able to explain the most important components, the manufacture, the structure, the most important characteristics of the mechanical behaviour and the corrosion behaviour, the material testing and the fields of utilization of all relevant building materials.
Skills	The students are able to assess the usability of building materials for different applications and to select building materials according to their specific advantages and disadvantages. The students are able to prepare the mixture of a normal type concrete and to consider the mixture in respect to the actual rules and the connections between the characteristic concrete parameters. They are able to select suitable materials and mixtures to avoid damage processes.
Personal Competence	
Social Competence	The students are able to support each other to learn the very extensive specialist knowledge in learning groups and to carry out exercises in small groups in the lab.
Autonomy	The students are able to make the timing and the operation steps to learn the specialist knowledge of a very extensive field.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	Compulsory: No; Bonus: 10 %; Form: Presentation; Description:
Examination	Written exam
Examination duration and scale	2 h written exam
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Core Qualification: Compulsory Integrated Building Technology: Core Qualification: Compulsory Orientation Studies: Core Qualification: Elective Compulsory

Course L0248: Building Materials and Building Chemistry

Typ	Lecture
Hrs/wk	4
CP	4
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
Lecturer	Prof. Frank Schmidt-Döhl
Language	DE
Cycle	SoSe
Content	Cementing materials, aggregates, admixtures and other components in mortar and concrete, concrete, durability of cement bonded materials, repair of concrete structures, steel, cast iron, non-ferrous metals, metal corrosion, timber, plastics, natural stone, synthetic stones, mortar, masonry, glass, bitumen
Literature	Wendehorst, R.: Baustoffkunde. ISBN 3-8351-0132-3 Scholz, W.:Baustoffkenntnis. ISBN 3-8041-4197-8 Henning, O.; Knöfel, D.: Baustoffchemie. ISBN 3-345-00799-1 Knoblauch, H.; Schneider, U.: Bauchemie. ISBN 3-8041-5174-4

Course L0249: Building Materials and Building Chemistry

Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Frank Schmidt-Döhl, Andre Rössler
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0851: Mathematics II

Courses

Title	Typ	Hrs/wk	CP
Mathematics II (L2976)	Lecture	4	4
Mathematics II (L2977)	Recitation Section (large)	2	2
Mathematics II (L2978)	Recitation Section (small)	2	2

Module Responsible	Prof. Anusch Taraz
Admission Requirements	None
Recommended Previous Knowledge	Mathematics I
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students can name further concepts in analysis and linear algebra. They are able to explain them using appropriate examples. • Students can discuss logical connections between these concepts. They are capable of illustrating these connections with the help of examples. • They know proof strategies and can reproduce them.
Skills	• Students can model problems in analysis and linear algebra with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods. • Students are able to discover and verify further logical connections between the concepts studied in the course. • For a given problem, the students can develop and execute a suitable approach, and are able to critically evaluate the results.
Personal Competence	
Social Competence	• Students are able to work together in teams. They are capable to use mathematics as a common language. • In doing so, they can communicate new concepts according to the needs of their cooperating partners. Moreover, they can design examples to check and deepen the understanding of their peers.
Autonomy	• Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them. • Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard problems.
Workload in Hours	Independent Study Time 128, Study Time in Lecture 112
Credit points	8
Course achievement	Compulsory: Yes; Bonus: 10 %; Form: Excercises; Description:
Examination	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Core Qualification: Compulsory Civil- and Environmental Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Core Qualification: Compulsory Digital Mechanical Engineering: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory Computer Science in Engineering: Core Qualification: Compulsory Integrated Building Technology: Core Qualification: Compulsory Logistics and Mobility: Core Qualification: Compulsory Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Orientation Studies: Core Qualification: Elective Compulsory Naval Architecture: Core Qualification: Compulsory Process Engineering: Core Qualification: Compulsory Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory

Course L2976: Mathematics II	
Typ	Lecture
Hrs/wk	4
CP	4
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
Lecturer	Prof. Anusch Taraz
Language	DE
Cycle	SoSe
Content	Analysis: • power series and elementary functions • interpolation • integration (proper integrals, fundamental theorem, integration rules, improper integrals, parameter dependent integrals • applications of integration (volume and surface of bodies of revolution, lines and arc length, line integrals • numerical quadrature • periodic functions Linear Algebra: • general vector spaces: subspaces, Euclidean vector spaces • linear mappings: basis transformation, orthogonal projection, orthogonal matrices, householder matrices • linear regression: normal equations, linear discrete approximation • eigenvalues: diagonalising matrices, normal matrices, symmetric and Hermite matrices • system of linear differential equations • matrix factorizations: LR-decomposition, QR-decomposition, Schur decomposition, Jordan normal form, singular value decomposition
Literature	• T. Arens u.a. : Mathematik, Spektrum Akademischer Verlag, Heidelberg 2009 • W. Mackens, H. Voß: Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994 • W. Mackens, H. Voß: Aufgaben und Lösungen zur Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994 • G. Strang: Lineare Algebra, Springer-Verlag, 2003 • G. und S. Teschl: Mathematik für Informatiker, Band 1, Springer-Verlag, 2013

Course L2977: Mathematics II	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Anusch Taraz
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L2978: Mathematics II	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Anusch Taraz
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0660: Construction Industry and Construction Management

Courses

Title	Typ	Hrs/wk	CP
Construction Management (L0396)	Lecture	2	2
Construction Management (L0397)	Recitation Section (large)	1	2
Law of Building Contracts (L0408)	Lecture	1	1
Environmental Law (L0346)	Lecture	1	1

Module Responsible	Prof. Jürgen Grabe
Admission Requirements	None
Recommended Previous Knowledge	none
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After successful completion of the module, students are able to • understand basic knowledge of construction management, • choose appropiate methodes of construction project management to solve problems, • capture basic structures and antagonisms of European enviromental legislation, • locate and apply relevant enviromental regulations • implement any enviromental regulation to the realisation of an construction project and to capture the signifiacance for the civil engineer • recognize basic structures of general civil and construction law as well as standards for construction works • capture the content of contracts which are important for building design and execution.
Skills	
Personal Competence	
Social Competence	
Autonomy	
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	120 minutes
Assignment for the Following Curricula	Civil- and Environmental Engineering: Core Qualification: Compulsory

Course L0396: Construction Management

Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	• Project development • Project management • Announcement • Order acquisition • Project execution • Project supervision
Literature	• Vorlesungsskript, s. www.tuhh.de/gbt • Baugeräteliste BGL • Honorarordnung für Architekten und Ingenieure HOAI • Verdingungsordnung im Bauwesen VOB mit Kommentaren

Course L0397: Construction Management

Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0408: Law of Building Contracts	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Daniel Waterstraat
Language	DE
Cycle	SoSe
Content	• Detecting the legal foundations and connections of construction law • Awareness of legal "Control points" in the construction contract and the construction process • Construction contract law according to the BGB and VOB • public procurement according to national and EU laws • Engineers law
Literature	• Axel Maser, Baurecht nach BGB und VOB/B Grundlagenwissen für Architekten und Ingenieure, Id Verlag 1., Auflage 2005, 28,00 € • Schmeel ATB Baurecht, Auflage 2002, 34,80 € • Werner / Pastor, Der Bauprozess 11. Auflage 2005, 149,00 €

Course L0346: Environmental Law	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Friederike Mechel
Language	DE
Cycle	SoSe
Content	The lecture focusses on: • Structure of Environmental Legislation in Europe and Germany • Important international, European and German laws/legal regulations (Water Framework Directive, IED, etc.) • Interactions between Environmental Laws and Technical Standards
Literature	• Erbguth, Wilfried; Schlacke, Sabine, Umweltrecht, 6. Auflage 2016 • Gesetzessammlung Umweltrecht, 26. Auflage 2016 (Beck Texte im dtv)

Module M1627: Water and Environment

Courses

Title	Typ	Hrs/wk	CP
Project on Water, Environment, Traffic (L2462)	Project-/problem-based Learning	2	3
Water in the Environment (L2461)	Lecture	2	3

Module Responsible	Prof. Mathias Ernst
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge of chemistry
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can define generic material interactions between the environmental media. The can demonstrate their knowledge about natural as well as anthropogenic materials. They are capable of explaining the natural condition of waters and other environmental media.
Skills	Students are able to research environment-specific aspects of civil engineering independent. They can present their findings using accredited academic media (e.g. posters) and can give a short summary including scientific references.
Personal Competence	
Social Competence	Students can fulfil a complex environment-related assignment in the field of civil engineering by working in a team.
Autonomy	Individual students prepare aspects of the given group work independently.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	Compulsory: Yes; Bonus: None; Form: Presentation; Description: Team-Projektarbeit mit Präsentation
Examination	Written exam
Examination duration and scale	60 min
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Water and Environmental Engineering: Elective Compulsory Civil- and Environmental Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisation Water Technologies: Elective Compulsory

Course L2462: Project on Water, Environment, Traffic

Typ	Project-/problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Dozenten des SD B
Language	DE
Cycle	SoSe
Content	Lecturers of Civicl Engineering provide duties on environmentally relevant fields of civil engineering for smal student groups (max. 4 students).
Literature	aufgabenspeziifisch / according to corresponding tasks

Course L2461: Water in the Environment

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Mathias Ernst, Dozenten des SD B
Language	DE
Cycle	SoSe
Content	• Basics of global/regional Water Cycle • quality of water • natural/anthropogenic water ingredients • Basics water science • water legislation (EU/D)
Literature	Schwoerbel, J. 2005: Einführung in die Limnologie. Heidelberg: Elsevier Grohmann, A. u. a. 2011: Wasser. Berlin: de Gruyter Kluth, W. & Schmeddinck, U. 2013: Umweltrecht: Ein Lehrbuch. Wiesbaden: Springer

Module M1803: Engineering Mechanics II (Elastostatics)

Courses

Title	Typ	Hrs/wk	CP
Engineering Mechanics II (Elastostatics) (L0493)	Lecture	2	2
Engineering Mechanics II (Elastostatics) (L1691)	Recitation Section (large)	2	2
Engineering Mechanics II (Elastostatics) (L0494)	Recitation Section (small)	2	2

Module Responsible	Prof. Christian Cyron
Admission Requirements	None
Recommended Previous Knowledge	Engineering Mechanics I, Mathematics I (basic knowledge of rigid body mechanics such as balance of linear and angular momentum, basic knowledge of linear algebra like vector-matrix calculus, basic knowledge of analysis such as differential and integral calculus)
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Having accomplished this module, the students know and understand the basic concepts of continuum mechanics and elastostatics, in particular stress, strain, constitutive laws, stretching, bending, torsion, failure analysis, energy methods and stability of structures.
Skills	Having accomplished this module, the students are able to - apply the fundamental concepts of mathematical and mechanical modeling and analysis to problems of their choice - apply the basic methods of elastostatics to problems of engineering, in particular in the design of mechanical structures - to educate themselves about more advanced aspects of elastostatics
Personal Competence	
Social Competence	Ability to communicate complex problems in elastostatics, to work out solution to these problems together with others, and to communicate these solutions.
Autonomy	Self-discipline and endurance in tackling independently complex challenges in elastostatics; ability to learn also very abstract knowledge.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Core Qualification: Compulsory Civil- and Environmental Engineering: Core Qualification: Compulsory Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Elective Compulsory Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory Integrated Building Technology: Core Qualification: Compulsory Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Core Qualification: Compulsory Orientation Studies: Core Qualification: Elective Compulsory Naval Architecture: Core Qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Process Engineering: Core Qualification: Compulsory Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory

Course L0493: Engineering Mechanics II (Elastostatics)	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	SoSe
Content	The lecture Engineering Mechanics II introduces the fundamental concepts of stress and strain and explains how these can be used to characterize and compute elastic deformations of mechanical bodies under loading. The focus of the lecture lies on: • basis of continuum mechanics: stress, strain, constitutive laws • truss • torsion bar • beam theory: bending, moment of inertia of area, transverse shear • energy methods: Maxwell-Betti reciprocal work theorem, Castigliano's second theorem, theorem of Menabrea • strength of materials: maximum principle stress criterion, yield criteria according to Tresca and von Mises • stability of mechanical structures: Euler buckling strut
Literature	• Gross, D., Hauger, W., Schröder, J., Wall, W.A.: Technische Mechanik 1, Springer • Gross, D., Hauger, W., Schröder, J., Wall, W.A.: Technische Mechanik 2 Elastostatik, Springer

Course L1691: Engineering Mechanics II (Elastostatics)	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0494: Engineering Mechanics II (Elastostatics)	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0728: Hydromechanics and Hydrology

Courses

Title	Typ	Hrs/wk	CP
Hydrology (L0909)	Lecture	1	1
Hydrology (L0956)	Project-/problem-based Learning	1	2
Hydromechanics (L0615)	Lecture	2	2
Hydromechanics (L0616)	Project-/problem-based Learning	1	1

Module Responsible	Prof. Peter Fröhle
Admission Requirements	None
Recommended Previous Knowledge	Mathematics I, II and III Mechanics I und II
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are able to define the basic terms of hydromechanics, hydrology groundwater hydrology and water management. They are able to derive the basic formulations of i) hydrostatics, ii) kinematics of flows and iii) conservation laws and to describe and quantify the relevant processes of the hydrological water cycle. Besides, the students can describe the main aspects of rainfall-run-off-modelling and of established reservoir / storage models as well as the concepts of the determination of a unit-hydrograph.
Skills	The students are able to apply the fundamental formulations of hydromechanics to basic practical problems. Furthermore, they are able to run, explain and document basic hydraulic experiments. Besides, they are able to apply basic hydrological approaches and methods to simple hydrological problems. The students have the capability to exemplarily apply simple reservoir/storage models and a unit-hydrograph to given problems. In addition, the basic concepts of field-measurements of hydrological and hydrodynamic values can be described and the students are able to perform, analyze and assess respective measurements.
Personal Competence	
Social Competence	The students are able to work in groups in a goal-orientated, structured manner. They can explain their results sustainably in plenary sessions by use of peer learning approaches. Furthermore, they are able to prepare and present technical presentations for given topics in groups.
Autonomy	Students are capable of organising their individual work flow to contribute to the conduct of experiments and to present discipline-specific knowledge. They can provide each other with feedback and suggestions on their results. They are capable of reflecting their study techniques and learning strategy on an individual basis.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6

Course achievement

Compulsory	Bonus	Form	Description
Yes	None	Excercises	Übungsaufgaben Hydrologie
Yes	None	Subject theoretical and practical work	Durchführung, Dokumentation und Präsentation zu einem Versuchs Hydromechanik oder Hydraulik in Gruppen
Yes	None	Group discussion	Erstellung eine Posters zu einer Thematik aus dem Themengebiet der Hydrologie in Gruppen und Präsentation

Examination	Written exam
Examination duration and scale	150 minutes
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Core Qualification: Compulsory Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory

Course L0909: Hydrology	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	WiSe
Content	Introduction to basics of hydrology and groundwater hydrology: • Hydrological cycle • Data acquisition in hydrology • Data analyses and statistical assessment • Statistics of extremes • Regionalization methods for hydrological values • rainfall-run-off modelling on the basis of a unit hydrograph concept
Literature	Maniak, U. (2017). Hydrologie und Wasserwirtschaft: Eine Einführung für Ingenieure. Springer Vieweg. Skript "Hydrologie und Gewässerkunde"

Course L0956: Hydrology	
Typ	Project-/problem-based Learning
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	WiSe
Content	Introduction to basics of Hydrology: • Hydrological cycle • Data acquisition • Data analyses and statistical assessment • Statistics of extremes • Regionalization methods for hydrological values Rainfall-run-off modelling on the basis of a unit hydrograph conceps
Literature	Maniak, Hydrologie und Wasserwirtschaft, Eine Einführung für Ingenieure, Springer Skript Hydrologie und Gewässerkunde

Course L0615: Hydromechanics	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	WiSe

Content	Fundamentals of Hydromechanics
	• Characteristics of fluids
	• Hydrostatics
	• Kinematics of flows, laminar and turbulent flows
	• Conservation laws
	  ◦ Conservation of mass
	  ◦ Conservation of Energy
	  ◦ Momentum Equation
	• Application of conservation laws to flow conditions

Literature	Skript zur Vorlesung Hydromechanik/Hydraulik, Kapitel 1-2 Truckenbrodt, E.: Lehrbuch der angewandten Fluidmechanik, Springer Verlag, Berlin, 1998. Truckenbrodt, E.: Grundlagen und elementare Strömungsvorgänge dichtebeständiger Fluide / Fluidmechanik, Springer Verlag, Berlin, 1996.

Course L0616: Hydromechanics	
Typ	Project-/problem-based Learning
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0740: Structural Analysis I

Courses

Title	Typ	Hrs/wk	CP
Structural Analysis I (L0666)	Lecture	2	3
Structural Analysis I (L0667)	Recitation Section (large)	2	2
Structural Analysis I (L3133)	Recitation Section (small)	1	1

Module Responsible	Prof. Bastian Oesterle
Admission Requirements	None
Recommended Previous Knowledge	Mechanics I, Mathematics I
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After successfully completing this module, students can express the basic aspects of linear frame analysis of statically determinate and indeterminate systems.
Skills	After successful completion of this module, the students are able to distinguish between statically determinate and indeterminate structures. They are able to analyze state variables and to construct influence lines of statically determinate plane and spatial frame and truss structures.
Personal Competence	
Social Competence	Students can • participate in subject-specific and interdisciplinary discussions, • defend their own work results in front of others • promote the scientific development of colleagues • Furthermore, they can give and accept professional constructive criticism
Autonomy	The students are able work in-term homework assignments. Due to the in-term feedback, they are enabled to self-assess their learning progress during the lecture period, already.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	Compulsory: No; Bonus: 10 %; Form: Written elaboration; Description: Hausübungen mit Testat, betreut durch Studentische Tutoren (Tutorium)
Examination	Written exam
Examination duration and scale	90 minutes
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Core Qualification: Compulsory Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory

Course L0666: Structural Analysis I

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bastian Oesterle
Language	DE
Cycle	WiSe
Content	• modeling of structures • theory of plane and spacial structures • assessment of structural behaviour, degree of static indeterminacy and kinematics • analysis of forces and moments, as well as diplscements and rotations • principle of virtual work • influence lines • Force Method for statically indeterminate structures
Literature	• Vorlesungsmanuskript • Bletzinger et al.: Aufgabensammlung zur Baustatik: Übungsaufgaben zur Berechnung ebener Stabtragwerke. Hanser. • Dinkler: Grundlagen der Baustatik. Springer. • Marti: Baustatik. Ernst und Sohn.

Course L0667: Structural Analysis I	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Bastian Oesterle
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L3133: Structural Analysis I	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Bastian Oesterle
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0579: Structural Design

Courses

Title	Typ	Hrs/wk	CP
Basics in Structural Design (L0209)	Project-/problem-based Learning	2	4
Basics of Structural Design (L0205)	Lecture	2	1
Basics in Structural Design (L0208)	Recitation Section (large)	1	1

Module Responsible	Sebastian Rybczynski
Admission Requirements	None
Recommended Previous Knowledge	Contents of module "Principles of Building Materials and Building Physics"
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After attending the "Building Construction" module students are able • to define the basics of building regulations law • to explain load effects and associated concepts • to describe overriding conventions of the construction industry • to specify typical building components • to distinguish between different possibilities of load bearing behaviour and risks due to lack of stability • to explain the main objectivs of fire control.
Skills	After the successful completion of the "Building Construction" module, students will be able • to apply industry-specific drawing conventions • carry out preliminary dimensioning of basic building components • develop stability and foundation concepts • use BIM software • and to design and construct standard cross-sections due to structural aspects.
Personal Competence	
Social Competence	After attending the course students are able • to work in a team and to persent the results of the team work • to use the feedback from other students to improve the own results • to give a feedback to other students in a constructive manner
Autonomy	After attending the course students are able • to control and improve their knowledge with the help of weeekly presentations (lecture room) and tests (STUD.IP) • to divide the main task in different parts, to deduce the needed knowledge and to schedule the different work steps
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Subject theoretical and practical work
Examination duration and scale	Desing, Construction and prelimnary design in a written form
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Core Qualification: Compulsory Integrated Building Technology: Core Qualification: Compulsory

Course L0209: Basics in Structural Design	
Typ	Project-/problem-based Learning
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Sebastian Rybczynski
Language	DE
Cycle	WiSe
Content	• Constructing a small individuell buidling in groups of 4 persons • Analysing the informations and the contents of development plans and buidling regulation laws • Design of building components and approving of the funcionality (sealing, facades, roofs) • Design and approve of the funcionality of the component interconnections • Proofing and assessing of moisture behaviour, energy comsumption, acoustic protection and fire control • Assessing the building stabilty • Basics of building services • Each week the results of different work steps are presented in oral and written form
Literature	**Vortragsfolien der Lehrveranstaltung** stehen über STUD.IP zum download zur Verfügung **Neumann, Dietrich** (Hestermann, Ulf.; Rongen, Ludwig.; Weinbrenner, Ulrich) Frick/Knöll Baukonstructionslehre 1 / [Internet-Ressource] ISBN: 978-3-8351-9121-1 Wiesbaden : B.G. Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2006 **Frick[Begr.], Otto** (Knöll[Begr.], Karl.; Neumann, Dietrich.; Hestermann, Ulf.; Rongen, Ludwig.) Baukonstruktionslehre 2 / [Internet-Ressource] ISBN: 978-3-8348-9486-1 Wiesbaden : Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008 **Dierks, Klaus** (Wormuth, Rüdiger.) Baukonstruktion : [Einführung, Grundlagen, Gründungen, technische Ausrüstung, Wände, Geschossdecken, Treppen, Dächer, Fenster, Türen, Konstruktionsatlas] ISBN: 3804150454 (Gb.) ISBN: 978-3-8041-5045-4 Neuwied : Werner, 2007 **Schneider, Klaus-Jürgen** (Goris, Alfons.; Berner, Klaus) Bautabellen für Ingenieure : mit Berechnungshinweisen und Beispielen ; [auf CD-ROM: Stabwerksprogramm IQ 100 B, Tools für den konstr. Ingenieurbau, Fachinformationen, Normentexte] ISBN: 3804152287 Neuwied : Werner, 2006 **Wendehorst, Reinhard** (Wetzell, Otto W.,; Baumgartner, Herwig,; Deutsches Institut für Normung) Wendehorst Bautechnische Zahlentafeln ISBN: 978-3-8351-0055-8 ISBN: 3835100556 Stuttgart [u.a.] : Teubner Berlin [u.a.] : Beuth, 2007 **Neufert, Ernst** (Kister, Johannes) Bauentwurfslehre : Grundlagen, Normen, Vorschriften über Anlage, Bau, Gestaltung, Raumbedarf, Raumbeziehungen, Maße für Gebäude, Räume, Einrichtungen, Geräte mit dem Menschen als Maß und Ziel ; Handbuch für den Baufachmann, Bauherrn, Lehrenden und Lernenden ISBN: 978-3-8348-0732-8 (GB.) Wiesbaden : Vieweg + Teubner, 2009

Course L0205: Basics of Structural Design	
Typ	Lecture
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Sebastian Rybczynski
Language	DE
Cycle	WiSe
Content	• Basics of building regulation laws • Foundation of buildings • Sealing of basements • facades • Ceilings • Roofs • Windows, doors and post-and-beam constructions • Staircases • Basics of strucural engineering design • Structural fire prevention • Optional tests on STUD.IP
Literature	**Vortragsfolien der Lehrveranstaltung** stehen über STUD.IP zum download zur Verfügung **Schneider Bautabellen** (Hrsg. A. Albert) 23., überarbeitete Aufl. ISBN 978-3-8462-0880-9 Reguvis Fachmedien GmbH, 2018 **Neumann, Dietrich** (Hestermann, U.; Rongen, L.; Weinbrenner, U.) Frick/Knöll Baukonstructionslehre 1 / [Internet-Ressource] ISBN: 978-3-8351-9121-1 Wiesbaden: Vieweg+Teubner Verlag, 2006 **Frick, Otto** (Knöll, K.; Neumann, D.; Hestermann, U.; Rongen, L.) Baukonstruktionslehre 2 / [Internet-Ressource] ISBN: 978-3-8348-9486-1 Wiesbaden: Vieweg+Teubner Verlag, 2008 **Dierks, Klaus** (Wormuth, R.) Baukonstruktion ISBN: 978-3-8041-5045-4 Neuwied : Werner, 2007 **Neufert, Ernst** (Kister, J.) Bauentwurfslehre (42. Aufl.) ISBN: 978-3-8348-0732-8 Wiesbaden : Vieweg + Teubner, 2018 **Wendehorst, Reinhard** (Wetzell, O. W.,; Baumgartner, H.,) Wendehorst Bautechnische Zahlentafeln ISBN: 978-3-8351-0055-8 Stuttgart/Berlin: Teubner/Beuth, 2018

Course L0208: Basics in Structural Design	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Sebastian Rybczynski
Language	DE
Cycle	WiSe
Content	• Constructing a small individuell buidling in groups of 4 persons • Analysing the informations and the contents of development plans and buidling regulation laws • Design of building components and approving of the funcionality (sealing, facades, roofs) • Design and approve of the funcionality of the component interconnections • Proofing and assessing of moisture behaviour, energy comsumption, acoustic protection and fire control • Assessing the building stabilty • Basics of building services • Each week the results of different work steps are presented in oral and written form
Literature	**Vortragsfolien der Lehrveranstaltung** stehen über STUD.IP zum download zur Verfügung **Neumann, Dietrich** (Hestermann, Ulf.; Rongen, Ludwig.; Weinbrenner, Ulrich) Frick/Knöll Baukonstructionslehre 1 / [Internet-Ressource] ISBN: 978-3-8351-9121-1 Wiesbaden : B.G. Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2006 **Frick[Begr.], Otto** (Knöll[Begr.], Karl.; Neumann, Dietrich.; Hestermann, Ulf.; Rongen, Ludwig.) Baukonstruktionslehre 2 / [Internet-Ressource] ISBN: 978-3-8348-9486-1 Wiesbaden : Vieweg+Teubner Verlag / GWV Fachverlage GmbH, Wiesbaden, 2008 **Dierks, Klaus** (Wormuth, Rüdiger.) Baukonstruktion : [Einführung, Grundlagen, Gründungen, technische Ausrüstung, Wände, Geschossdecken, Treppen, Dächer, Fenster, Türen, Konstruktionsatlas] ISBN: 3804150454 (Gb.) ISBN: 978-3-8041-5045-4 Neuwied : Werner, 2007 **Schneider, Klaus-Jürgen** (Goris, Alfons.; Berner, Klaus) Bautabellen für Ingenieure : mit Berechnungshinweisen und Beispielen ; [auf CD-ROM: Stabwerksprogramm IQ 100 B, Tools für den konstr. Ingenieurbau, Fachinformationen, Normentexte] ISBN: 3804152287 Neuwied : Werner, 2006 **Wendehorst, Reinhard** (Wetzell, Otto W.,; Baumgartner, Herwig,; Deutsches Institut für Normung) Wendehorst Bautechnische Zahlentafeln ISBN: 978-3-8351-0055-8 ISBN: 3835100556 Stuttgart [u.a.] : Teubner Berlin [u.a.] : Beuth, 2007 **Neufert, Ernst** (Kister, Johannes) Bauentwurfslehre : Grundlagen, Normen, Vorschriften über Anlage, Bau, Gestaltung, Raumbedarf, Raumbeziehungen, Maße für Gebäude, Räume, Einrichtungen, Geräte mit dem Menschen als Maß und Ziel ; Handbuch für den Baufachmann, Bauherrn, Lehrenden und Lernenden ISBN: 978-3-8348-0732-8 (GB.) Wiesbaden : Vieweg + Teubner, 2009

Module M0706: Geotechnics I

Courses

Title	Typ	Hrs/wk	CP
Soil Mechanics (L0550)	Lecture	2	2
Soil Mechanics (L0551)	Recitation Section (large)	2	2
Soil Mechanics (L1493)	Recitation Section (small)	2	2

Module Responsible	Prof. Jürgen Grabe
Admission Requirements	None
Recommended Previous Knowledge	Modules : • Mechanics I-II
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students know the basics of soil mechanics as the structure and characteristics of soil, stress distribution due to weight, water or structures, consolidation and settlement calculations, as well as failure of the soil due to ground- or slope failure.
Skills	After the successful completion of the module the students should be able to describe the mechanical properties and to evaluate them with the help of geotechnical standard tests. They can calculate stresses and deformation in the soils due to weight or influence of structures. They are are able to prove the usability (settlements) for shallow foundations.
Personal Competence	
Social Competence	
Autonomy	
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	Compulsory: No; Bonus: 20 %; Form: Attestation; Description:
Examination	Written exam
Examination duration and scale	90 minutes
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Core Qualification: Compulsory Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory

Course L0550: Soil Mechanics

Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	• Structure of the soil • Ground surveying • Compsitition and properties of the soil • Groundwater • One-dimensional compression • Spreading of stresses • Settlement calculation • Consolidation • Shear strength • Earth pressure • Slope failure • Ground failure • Suspension based earth tenches
Literature	• Vorlesungsumdruck, s. ww.tu-harburg.de/gbt • Grabe, J. (2004): Bodenmechanik und Grundbau • Gudehus, G. (1981): Bodenmechanik • Kolymbas, D. (1998): Geotechnik - Bodenmechanik und Grundbau • Grundbau-Taschenbuch, Teil 1, aktuelle Auflage

Course L0551: Soil Mechanics	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1493: Soil Mechanics	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1082: Mathematics III - Differential Equations I

Courses

Title	Typ	Hrs/wk	CP
Differential Equations 1 (Ordinary Differential Equations) (L1031)	Lecture	2	2
Differential Equations 1 (Ordinary Differential Equations) (L1032)	Recitation Section (small)	1	1
Differential Equations 1 (Ordinary Differential Equations) (L1033)	Recitation Section (large)	1	1

Module Responsible	Dozenten des Fachbereiches Mathematik der UHH
Admission Requirements	None
Recommended Previous Knowledge	Mathematics I and II
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students can name the basic concepts in Mathematics III. They are able to explain them using appropriate examples. • Students can discuss logical connections between these concepts. They are capable of illustrating these connections with the help of examples • They know proof strategies and can reproduce them.
Skills	• Students can model problems in Mathematics III with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods • Students are able to discover and verify further logical connections between the concepts studied in the course. • For a given problem, the students can develop and execute a suitable approach, and are able to critically evaluate the results.
Personal Competence	
Social Competence	• Students are able to work together in teams. They are capable to use mathematics as a common language. • In doing so, they can communicate new concepts according to the needs of their cooperating partners. Moreover, they can design examples to check and deepen the understanding of their peers.
Autonomy	• Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them. • Students have developed sufficient persistence to be able to work for longer periods in a goad-oriented manner on hard problems.
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
Credit points	4
Course achievement	None
Examination	Written exam
Examination duration and scale	60 min
Assignment for the Following Curricula	Civil- and Environmental Engineering: Core Qualification: Compulsory

Course L1031: Differential Equations 1 (Ordinary Differential Equations)

Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	WiSe
Content	Main features of the theory and numerical treatment of ordinary differential equations • Introduction and elementary methods • Exsitence and uniqueness of initial value problems • Linear differential equations • Stability and qualitative behaviour of the solution • Boundary value problems and basic concepts of calculus of variations • Eigenvalue problems • Numerical methods for the integration of initial and boundary value problems • Classification of partial differential equations
Literature	• http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html

Course L1032: Differential Equations 1 (Ordinary Differential Equations)	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1033: Differential Equations 1 (Ordinary Differential Equations)	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0613: Reinforced Concrete Structures I

Courses

Title	Typ	Hrs/wk	CP
Project Seminar Concrete I (L0896)	Seminar	1	1
Reinforced Concrete Design I (L0303)	Lecture	2	3
Reinforced Concrete Design I (L0305)	Recitation Section (large)	2	2

Module Responsible	Prof. Günter Rombach
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge in structural analysis and building materials. Modules: Structural Analysis I, Mechanics I+II
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can outline the history of concrete construction and explain the basics of structural engineering, including usual load combinations and safety concepts. They are able to draft and dimension simple structures, as well as to evaluate and discuss the behaviour of the materials and of structural members.
Skills	The students are able to apply basic procedures of the conception and dimensioning to practical cases. They are capable to draft simple concrete structures and to design them for bending and bending with axial force, and to plan their detailing and execution. Moreover, they can make design and construction sketches and draw up technical descriptions.
Personal Competence	
Social Competence	Students will be able to produce results of high quality in working groups.
Autonomy	The students are able to carry out simple tasks in the conception and dimensioning of structures and to critically reflect the results.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	**Compulsory** / **Bonus** / **Form** / **Description** No / None / Excercises
Examination	Written exam
Examination duration and scale	120 minutes
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Core Qualification: Compulsory

Course L0896: Project Seminar Concrete I

Typ	Seminar
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Günter Rombach
Language	DE
Cycle	SoSe
Content	In the course of the project seminar, a simple structure is drafted and dimensioned.
Literature	Download der Unterlagen zur Vorlesung über Stud.IP!

Course L0303: Reinforced Concrete Design I	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Günter Rombach
Language	DE
Cycle	SoSe
Content	The following subjects/contents are treated: • history of concrete construction • building materials: mechanical and physical-chemical properties of concrete, steel, GFRP, CFRP • Introduction in safety concepts, ultimate limit states and safety coefficients • actions on structures • design of linear concrete members with arbitrary cross section for tension and bending with/without axial force • design of slender columns
Literature	Download der Unterlagen zur Vorlesung über Stud.IP! • Zilch K., Zehetmaier G.: Bemessung im konstruktiven Betonbau. Springer Verlag, 2010 • König G., Tue N.: Grundlagen des Stahlbetonbaus, 3. Auflage, Teubner-Verlag, 2008 • Deutscher Beton- und Bautechnikverein E.V.: Beispiele zur Bemessung von Betontragwerken nach Eurocode 2. Band 1: Hochbau, Bauverlag GmbH, Wiesbaden 2011 • Fingerlos F., Hegger J., Zilch K.: Eurocode 2 für Deutschland. Berlin 2016 • Dahms K.-H.: Rohbauzeichnungen, Bewehrungszeichnungen. Bauverlag, Wiesbaden 1997 • Grasser E., Thielen G.: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen von Stahlbetontragwerken. Deutscher Ausschuss für Stahlbeton, Heft 240, Verlag Ernst & Sohn, Berlin 1978

Course L0305: Reinforced Concrete Design I	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Günter Rombach
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0744: Structural Analysis II

Courses

Title	Typ	Hrs/wk	CP
Structural Analysis II (L0673)	Lecture	2	3
Structural Analysis II (L0674)	Recitation Section (large)	2	2
Structural Analysis II (L3134)	Recitation Section (small)	1	1

Module Responsible	Prof. Bastian Oesterle
Admission Requirements	None
Recommended Previous Knowledge	• Mechanics I/II • Mathematics I/II • Differential Equations I • Structural Analysis I
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After successful completion of this module, students can express the basic aspects of linear frame analysis of statically indeterminate systems.
Skills	After successful completion of this module, the students are able to analyze state variables and to construct influence lines of statically inderminate plane and spatial frame and truss structures.
Personal Competence	
Social Competence	Students can • participate in subject-specific and interdisciplinary discussions, • defend their own work results in front of others • promote the scientific development of colleagues • Furthermore, they can give and accept professional constructive criticism
Autonomy	The students are able to work in-term homework assignments. Due to the in-term feedback, they are enabled to self-assess their learning progress during the lecture period, already.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6

Course achievement

Compulsory	Bonus	Form	Description
No	10 %	Written elaboration	Hausübungen mit Testat, betreut durch Studentische Tutoren (Tutorium)

Examination	Written exam
Examination duration and scale	90 minutes
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Core Qualification: Compulsory

Course L0673: Structural Analysis II	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bastian Oesterle
Language	DE
Cycle	SoSe
Content	• Analysis of statically indeterminant structures, force method • displacement method • computational methods, direct stiffness method • introduction to the finite element method • elastically supported structures
Literature	• Vorlesungsmanuskript • Bletzinger et al.: Aufgabensammlung zur Baustatik: Übungsaufgaben zur Berechnung ebener Stabtragwerke. Hanser. • Dinkler: Grundlagen der Baustatik. Springer. • Marti: Baustatik. Ernst und Sohn.

Course L0674: Structural Analysis II	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Bastian Oesterle
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L3134: Structural Analysis II	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Bastian Oesterle
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0686: Sanitary Engineering I

Courses

Title	Typ	Hrs/wk	CP
Wastewater Disposal (L0276)	Lecture	2	2
Wastewater Disposal (L0278)	Recitation Section (large)	1	1
Drinking Water Supply (L0306)	Lecture	2	1
Drinking Water Supply (L0308)	Recitation Section (large)	1	2

Module Responsible	Prof. Ralf Otterpohl
Admission Requirements	None
Recommended Previous Knowledge	• Basic knowledge on Chemistry and Biology • Hydraulics of pipe systems and open channels • Basic knowledge on water management: water quantity and water quality • Basic knowledge on Environmental Legislation: Federal Water Act
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can examplify their expert knowledge on urban water infrastructures. They can present the derivation and detailed explanation of important standards for the design of drinking water supply and wastewater disposal systems in Germany and they are capable of reproducing the relevant empiricals assumptions and scientific simplifcations. The students are able to present and discuss sanitary engineering processes and the technologies used for drinking and wastewater treatment. They can also assess existing problems in the field of sanitary engineering by considering legal, risk and saftey aspects. Furthermore, they know how to draft the features and effectiveness of important technologies of the future such as high- and low-pressure membrane filtration systems and techniques for the removal of trace pollutants.
Skills	The students are able to apply the relevant standards and guidelines for the design and operation of urban water infrastructures independently. Their expertise comprises expert skills to design drinking water supply and urban drainage systems as well as the associated treatment facilities. Besides the acquirement of technical skills the students are able to address and solve biochemical problems in the filed of drinking water and wastewater treatment. The students are also able to develop ideas of their own to improve the existing water related infrastructures, systems and concepts.
Personal Competence	
Social Competence	Social skills are not targeted in this module.
Autonomy	Students are able to form concepts on their own to optimize urban water infrastructure processes. Therefore they can acquire appropriate knowledge when being given some clues or information with regard to the approach to problems (preparation and follow-up of the exercises).
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Green Technologies: Compulsory Civil- and Environmental Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory Integrated Building Technology: Core Qualification: Compulsory

Course L0276: Wastewater Disposal	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	DE
Cycle	SoSe
Content	This lecture focusses on urban drainage and wastewater treatment. Urban Drainage • Design of urban drainage systems (combined and separate sewer systems) • Special structures • Rainwater management Wastewater treatement • Mechanical treatment (Screens, Grit chamber, Preliminary Sedimentation, Secondary Settlement Tanks, Membrane Filtration) • Biological Treatment (aerobic, anaerobic, anoxic) • Special Wastewater Treatment Processes (Ozonation, Adsorption)
Literature	Die hier aufgeführte Literatur ist in der Bibliothek der TUHH verfügbar. The literature listed below is available in the library of the TUHH. • Taschenbuch der Stadtentwässerung : mit 10 Tafeln und 67 Tabellen, Imhoff, K., & . (2009). (31., verbesserte Aufl.). München: Oldenbourg Industrieverl. • Abwasser : Technik und Kontrolle. Neitzel, Volkmar, and. . Weinheim [u.a.]: Wiley-VCH, 1998. • Kommunale Kläranlagen : Bemessung, Erweiterung, Optimierung, Betrieb und Kosten, (2009). Günthert, F. Wolfgang: (3., völlig neu bearb. Aufl.). Renningen: expert-Verl. • Water and wastewater technology Hammer, M. J. 1., & . (2012). (7. ed., internat. ed.). Boston [u.a.]: Pearson Education International. • Water and wastewater engineering : design principles and practice: Davis, M. L. 1. (2011). . New York, NY: McGraw-Hill. • Biological wastewater treatment: (2011). C. P. Leslie Grady, Jr. (3. ed.). London, Boca Raton, Fla. [u.a.]: IWA Publ.

Course L0278: Wastewater Disposal	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Ralf Otterpohl
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0306: Drinking Water Supply	
Typ	Lecture
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dr. Klaus Johannsen, Prof. Mathias Ernst
Language	DE
Cycle	SoSe
Content	The lecture on drinking water supply provides students with a basic understanding of the entire water supply system, encompassing water catchment, water treatment including pump systems, water storage, and the distribution system that carries water to the consumer. Initially, basics in hydraulics and pump systems are presented (system curve and pump curve). Students learn how the duty point of the pump is determined. Students learn about different water resources and will be able to design groundwater wells. Students learn how to determine water demand and derive planning values for designing the different elements of a water supply system (e.g. firefighting requirements). The functions of reservoirs, their design and arrangement in the water supply system are explained. Students will be able to design simple water distribution systems. A further part of the lecture deals with the processes involved in drinking water supply. This includes a presentation of the essential mechanisms and layout parameters for sedimentation, filtration, coagulation, membrane treatment, adsorption, water softening, gas exchange, ion exchange and disinfection. The basics of process treatment technology will be built on with parallel analysis of the impacts on chemical and physical water quality parameters.
Literature	Gujer, Willi (2007): Siedlungswasserwirtschaft. 3., bearb. Aufl., Springer-Verlag. Karger, R., Cord-Landwehr, K., Hoffmann, F. (2005): Wasserversorgung. 12., vollst. überarb. Aufl., Teubner Verlag Rautenberg, J. et al. (2014): Mutschmann/Stimmelmayr Taschenbuch der Wasserversorgung. 16. Aufl., Springer-Vieweg Verlag. DVGW Lehr- und Handbuch Wasserversorgung: Wasseraufbereitung - Grundlagen und Verfahren, m. CD-ROM: Band 6 (2003).

Course L0308: Drinking Water Supply	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Dr. Klaus Johannsen, Prof. Mathias Ernst
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0611: Steel Structures I

Courses

Title	Typ	Hrs/wk	CP
Steel Structures I (L0299)	Lecture	2	3
Steel Structures I (L0300)	Recitation Section (large)	2	3

Module Responsible	Prof. Marcus Rutner
Admission Requirements	None
Recommended Previous Knowledge	• Structural analysis I, Structural analysis II • Mechanics I, Mechanics II • Building Materials and Building Chemistry • Principles of Building Materials and Building Physics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After passing this module students are able to • give a summary of the security concept • explain the priciples of the design process • describe and illustrate the bhaviour of memers in tension, compression and bending
Skills	Students can rate and apply the material steel appropiately with respect to its properties and usage. They can use the security concept with respect to loads, forces and resistances. They can check the ultimate limit state and the serviceability of simple members in tension, compression and bending.
Personal Competence	
Social Competence	After participation of an optional course (building of a simple truss) they are able to organize themselves in groups. They will be successful in guided building a truss with bolted connections according to design drawings.
Autonomy	--
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	120 minutes
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Core Qualification: Compulsory

Course L0299: Steel Structures I

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	WiSe
Content	• Introduction to steel constructions • Materials • Design and security model • Tension rods • Beams (elsatic and plastic design • Column design • Bolted connections
Literature	Petersen, C.: Stahlbau, 4. Auflage 2013, Springer-Vieweg Verlag Wagenknecht, G.: Stahlbau-Praxis nach Eurocode 3, Bauwerk-Verlag 2011 • Band 1 Tragwerksplanung, Grundlagen • Band 2 Verbindungen und Konstruktionen

Course L0300: Steel Structures I

Typ	Recitation Section (large)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0869: Hydraulic Engineering

Courses

Title	Typ	Hrs/wk	CP
Hydraulics (L0957)	Lecture	1	1
Hydraulics (L0958)	Project-/problem-based Learning	1	1
Hydraulic Engineering (L0959)	Lecture	2	2
Hydraulic Engineering (L0960)	Project-/problem-based Learning	1	2

Module Responsible	Prof. Peter Fröhle
Admission Requirements	None
Recommended Previous Knowledge	Hydraulic Mechanics and Hydrology
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to define the basic terms of hydraulic engineering and hydraulics. They are able to explain the application of basic hydrodynamic formulations (conservation laws) to practical hydraulic engineering problems. Besides this, the students can illustrate important tasks of hydraulic engineering and give an overview over river engineering, flood protection, hydraulic power engineering and waterways engineering.
Skills	The students are able to apply hydraulic engineering methods and approaches to basic practical problems and design respective hydraulic engineering systems. Besides this, they are able to use and apply established approaches of hydraulics and determine water surfaces of channel flows, influences of constructions (weirs, etc.) on channel flows as well as flow conditions of pipe system. Furthermore, they are able to run, explain and document basic hydraulic experiments.
Personal Competence	
Social Competence	The students are able to deploy their gained knowledge in applied problems. Additionaly, they will be able to work in team with engineers of other disciplines in a goal-orientated, structured manner. They can explain their results by use of peer learning approaches.
Autonomy	The students will be able to independently extend their knowledge and apply it to new problems. Furthermore, they are capable of organising their individual work flow to contribute to the conduct of experiments and to present discipline-specific knowledge.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	**Compulsory** / **Bonus** / **Form** / **Description**: Yes / None / Subject theoretical and practical work / Durchführung, Dokumentation und Präsentation zu einem Versuchs Hydromechanik oder Hydraulik
Examination	Written exam
Examination duration and scale	The duration of the examination is 2.5 hours. The examination includes tasks with respect to the general understanding of the lecture contents and calculations tasks.
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Water and Environmental Engineering: Elective Compulsory Civil- and Environmental Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisation Water Technologies: Elective Compulsory

Course L0957: Hydraulics

Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	WiSe/SoSe

Content	Flow of incompressible fluids in pipes and open channels
	• Pumps in hydraulic systems
	• Open channel flow
	• Regulative construction in open channel flow
	  ◦ Weirs
	  ◦ Sliding panels
	  ◦ Cross-section reduction by constructions

Literature	Zanke, Ulrich C. , Hydraulik für den WasserbauUrsprünglich erschienen unter: Schröder/Zanke "Technische Hydraulik", Springer-Verlag, 2003 Naudascher, E.: Hydraulik der Gerinne und Gerinnebauwerke, Springer, 1992

Course L0958: Hydraulics	
Typ	Project-/problem-based Learning
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	WiSe/SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0959: Hydraulic Engineering	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	WiSe/SoSe

Content	Fundamentals of hydraulic engineering
	• Introduction and hydrological cycle
	• River engineering
	  ◦ Regime theory of natural rivers
	  ◦ Sediment transport
	  ◦ Regulation of rivers
	  ◦ Bank protection / protection of river bed
	  ◦ Tidal rivers
	• Flood protection
	  ◦ Dikes
	  ◦ Flood contraol basins
	• Hydraulic power
	• Inland waterways engineering
	  ◦ waterways
	  ◦ Locks and ship lifts
	  ◦ Fish passages
	• Nature-oriented hydraulic engineering

Literature	Strobl, T. & Zunic, F: Wasserbau, Springer 2006 Patt, H. & Gonsowski, P: Wasserbau, Springer 2011

Course L0960: Hydraulic Engineering	
Typ	Project-/problem-based Learning
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	WiSe/SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1953: Applications in Civil + Environmental Engineering

Courses

Title	Typ	Hrs/wk	CP
Applied Structural Dynamics (L0791)	Lecture	2	2
Soil Laboratory Course (L0499)	Practical Course	1	2
Computational Analysis of Structures (L0370)	Lecture	2	3
Digitalization and sustainability in AEC (L2868)	Project Seminar	3	3
Introduction in Statitics with R (L0286)	Lecture	1	1
Introduction in Statitics with R (L0776)	Recitation Section (large)	1	1
Excursion construction projects (L1228)	Project Seminar	2	2
Principles of Geomatics (L0470)	Lecture	2	2
Principles of Geomatics (L0471)	Recitation Section (small)	2	2
Numeric and Matlab (L0125)	Practical Course	2	2
Practical Course in Drinking Water Chemistry (L1744)	Practical Course	1	2
Special topics of Civil- and Environmental Engineering (L2411)		1	1
Special topics of Civil- and Environmental Engineering 2 LP (L2412)		2	2
Special topics of Civil- and Environmental Engineering 3LP (L2413)		3	3
Fire Protection and Prevention (L0472)	Lecture	2	2

Module Responsible	Prof. Peter Fröhle
Admission Requirements	None
Recommended Previous Knowledge	none
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are at home doing with typical applications of the study programme.
Skills	The students are able to use the methods that are provided during the lectures for practical questions. They are able to work in the learnt methods into new forms of application independently".
Personal Competence	
Social Competence	According to the course chosen students are able to perform tasks or to conduct a project in teams. If so, they can present, discuss and document results accordingly.
Autonomy	According to the course chosen individual students can plan and document tasks and work flow for themselves or for the team.
Workload in Hours	Depends on choice of courses
Credit points	7
Assignment for the Following Curricula	Civil- and Environmental Engineering: Core Qualification: Compulsory

Course L0791: Applied Structural Dynamics	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	15 min
Lecturer	Dr. Kira Holtzendorff
Language	DE
Cycle	WiSe
Content	The lecture gives an introduction into the classical structural dynamics, whereas the focus lies on the practical applications. The theoretical basics are worked out in order to apply them for typical issues in practice. For an effective vibration isolation due to vibration excitations by e.g. railway traffic, operating machines oder moving people, different structural measures are presented. The lecture is completed by performing examples of vibration measurements as well as interactive dynamic experiments in the laboratory. The following topics are covered: Particular features in structural dynamics Basic terms of time-dependent excitations Free vibrations (natural frequencies) Induced vibrations Impact excitations of structures Methods of amplitude reduction (vibration isolation) Introduction to soil dynamics Vibration measurements and requirements for vibration protection Vibrations induced by people
Literature	Helmut Kramer: Angewandte Baudynamik, Ernst & Sohn Verlag, 2. Auflage 2013 Christian Petersen: Dynamik der Baukonstruktionen, Vieweg Verlag, 2. Auflage von 2000

Course L0499: Soil Laboratory Course	
Typ	Practical Course
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Schriftliche Ausarbeitung
Examination duration and scale	Die gesamte Arbeitszeit im Praktikum plus anschließender Bericht = 90 Stunden Arbeitszeit (Das Erstellen der Ausarbeitung = Bearbeitungszeitraum von 4 Wochen und ein Umfang von maximal 50 Seiten.)
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	WiSe
Content	• Field experiments • Short lecture on laboratory tests • soil analysis • laboratory test • soil clasification • Creating a ground and foundation report
Literature	• DIN-Taschenbuch 113, Erkundung und Untersuchung des Baugrundes

Course L0370: Computational Analysis of Structures	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Examination Form	Klausur
Examination duration and scale	60 min
Lecturer	Prof. Günter Rombach
Language	DE
Cycle	WiSe
Content	• basics of the Finite Element Method, Spreadsheets • basics of software 'SOFiSTiK' • modeling of an arbitrary cross-section • modeling of an arbitrary 2D truss structure incl. loads • Teddy: usage of global and local variables • design of a concrete section • modeling of a T-beam bridge by means of a grillage system • modeling and design of a rectangular slab • building models
Literature	• Vorlesungsunterlagen können im STUDiP heruntergeladen werden • Tutorials von SOFiSTiK • Rombach G.: Anwendung der Finite - Elemente - Methode im Betonbau. 2. Auflage. Verlag Ernst &.Sohn, Berlin, 2007 • Rombach G.: Finite-Element Design of Concrete Structures. 2nd edition, ICE Publishing, London, 2011, ISBN 0 7277 32749 • Rombach G.: EDV-unterstützte Berechnungen im Stahlbetonbau. in: „Stahlbetonbau aktuell 2014" (ed. Gorris A., Hegger J., Mark P.), Berlin 2014 (S. C1.-C.36)

Course L2868: Digitalization and sustainability in AEC	
Typ	Project Seminar
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	Schriftliche Ausarbeitung
Examination duration and scale	90 Minuten
Lecturer	Dr. Thomas Kölzer
Language	EN
Cycle	WiSe
Content	• Facts about climate change: Modern lifestyle, emissions, damages etc. • Concepts and organizations: C2C, IPCC, SDGs etc. • Discussion: Nature vs. technology (philosophical views) • The role of AEC regrading sustainability: Cement, sand, timber, transport etc. • Backgrounds: Emissions, gases, greenhouse effect etc. • Energy: fossil and renewable sources: Biomass, coal, oil, gas, sun, wind, water etc. • Digital technologies: VR, AR, apps, sensors, scanners, robotics, cameras etc. • Digital concepts: Big data, blockchain, artificial Intelligence, machine Learning etc. • Digital infrastructures: Smart cities, digital twins, autonomous driving, digital contracts etc. • Digital applications in AEC: Scan-to-BIM, computer vision, structural health monitoring, Construction robotics, generative design etc. • Innovative combinations between ecological and digital elements
Literature	• Alpaydin (2016): Machine Learning • Boden (2018): Artificial Intelligence • Borrmann et al. (2019): Building Information Modeling • Braungart (2020): Cradle to Cradle - Remaking The Way We Make Things • Dasgupta (2016): Computer Science • Edenhofer & Jakob (2019): Klimapolitik • Hausknecht & Liebich (2016): BIM-Kompendium • Holmes (2017): Big Data • IPCC (2021): Assessment reports 1-6 • Jelley (2020): Renewable Energy • Jenkins (2019): Energy Systems • Jonas (1979): Das Prinzip Verantwortung • Lenzen (2020): Künstliche Intelligenz • Maslin (2014): Climate Change • Portney (2015): Sustainability • Rahmstorf & Schellnhuber (2019): Der Klimawandel • Schirrmacher et al. (2015): Technologischer Totalitarismus • Thoreau (1854): Walden • Winfield, Alan (2012): Robotics

Course L0286: Introduction in Statitics with R	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Klausur
Examination duration and scale	60 min
Lecturer	Dr. Joachim Behrendt
Language	DE
Cycle	WiSe
Content	Introduction to R Graphics with R Descriptive Statistic (Boxplot, Percentiles, outliers) Propability (Combinatorics, relative frequency, dependand probability) random numbers and distibutions (confidence interval, uniform and discrete distributions, test-distributions (t-F-X²-distribiution)) Correlation and Regression analysis (Confidence interval of calibration curves, linearity) Statistic test procedures (mean value-t-Test, Chi^2-Test, F-Test) Analysis of variance (ANOVA, Bartlett-Test, Kruskal-Wallis Rank sum test) Introduction time series (tseries) Introduction cluster analysis (k-means)
Literature	**Regionales Rechenzentrum für Niedersachsen** Statistik mit R Grundlagen der Datenanalyse , 2013 Einführung in die Statistik mit R, Andreas Handl, Skript Uni Bielefeld http://www.wiwi.uni-bielefeld.de/fileadmin/emeriti/frohn/handl_grundausbildung/statskript.pdf und die dazugehörige Aufgabensammlung http://www.wiwi.uni-bielefeld.de/fileadmin/emeriti/frohn/handl_grundausbildung/statauf.pdf Induktive Statistik [Elektronische Ressource] : eine Einführung mit R und SPSS / Helge... von Toutenburg, Helge 2008 http://dx.doi.org/10.1007/978-3-540-77510-2http://dx.doi.org/10.1007/978-3-540-77510-2 R-Referenzcard: http://cran.r-project.org/doc/contrib/Short-refcard.pdfhttp://cran.r-project.org/doc/contrib/Short-refcard.pdf Grafiken und Statistik in R von Andreas Plank Nachschlage Skript mit Beispielen: http://www.geo.fu-berlin.de/geol/fachrichtungen/pal/mitarbeiter/plank/FormeIn_in_R.pdfhttp://www.geo.fu-berlin.de/geol/fachrichtungen/pal/mitarbeiter/plank/FormeIn_in_R.pdf

Course L0776: Introduction in Statitics with R	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	Klausur
Examination duration and scale	siehe Vorlesung
Lecturer	Dr. Joachim Behrendt
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1228: Excursion construction projects	
Typ	Project Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Referat
Examination duration and scale	ca. zehnminütige Präsentation
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	Excursions to different construction and enviromental projects.
Literature	keine

Course L0470: Principles of Geomatics	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and scale	schriftliche Ausarbeitungen zu allen fünf Übungen, ggf. Testklausur
Lecturer	Dr. Annette Scheider, Prof. Kay Smarsly
Language	DE
Cycle	SoSe
Content	• Overview of geomatics in general • Units of measurements • Generating of topographical maps • Basic surveying instruments and handling • Geodetic surveying lines and verification of measurements • Methods of horizontal survey • Components of geodetic surveying instruments • Height determination • Setting out points • Topographical survey • Directions and angles • Determination of coordinates • Traversing • Basics on surveying and positioning with GNSS
Literature	Andree, P.: Grundlagen der Geomatik (Skript) Resnik, B. / Bill, R.: Vermessungskunde für den Planungs- Bau- und Umweltbereich, Wichmann-verlag Witte, B. / Sparla, P.: Vermessungskunde und Grundlagen der Statistik für das Bauwesen, Wichmann-Verlag Gruber, F.J. / Joeckel, R.: Formelsammlung für das Vermessungswesen, Vieweg + Teubner-Verlag

Course L0471: Principles of Geomatics	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Schriftliche Ausarbeitung
Examination duration and scale	.
Lecturer	Dr. Annette Scheider, Prof. Kay Smarsly
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0125: Numeric and Matlab	
Typ	Practical Course
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Fachtheoretisch-fachpraktische Arbeit
Examination duration and scale	5 Übungsaufgaben jeweils mit Testat am Ende
Lecturer	Dr. Stefan Benders, Prof. Siegfried Rump
Language	DE
Cycle	SoSe
Content	1. Programming in Matlab 2. Numerical methods for systems of nonlinear equations 3. Basics in computer arithmetic 4. Linear and nonlinear optimization 5. Condition of problems and algorithms 6. Verified numerical results with INTLAB
Literature	**Literatur (Software-Teil):** 1. Moler, C., Numerical Computing with MATLAB, SIAM, 2004 2. The Math Works, Inc. , MATLAB: The Language of Technical Computing, 2007 3. Rump, S. M., INTLAB: Interval Labority, http://www.ti3.tu-harburg.de 4. Highham, D. J.; Highham, N. J., MATLAB Guide, SIAM, 2005

Course L1744: Practical Course in Drinking Water Chemistry	
Typ	Practical Course
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Examination Form	Fachtheoretisch-fachpraktische Arbeit
Examination duration and scale	6 Versuchsprotokolle
Lecturer	Dr. Klaus Johannsen
Language	DE
Cycle	WiSe
Content	!Max.12 students! The students learn basic experimental work in the laboratory. The experiments give an overview about the most important chemical analysis methods of drinking water. This includes sampling, photometric measurement, complexometric titration as well as acid/base titration. The experiments are strongly related to the processes in drinking water treatment and water distribution (e. g. removal of iron and manganese, softening and conditioning). Instrumental analytics is not subject of this practical course. 1. Day: Introduction, safety instructions 2. Day: Electrical conductivity, saturation with respect to calcite, hardness 3. Day: Organic carbon, iron, acid and base neutralization capacity 4. Day: Writing protocols of experiments and presentations 5. Day: Evaluation of the protocols and presentations, final discussion
Literature	Siehe Skript. See Script.

Course L2411: Special topics of Civil- and Environmental Engineering	
Typ	
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Examination Form	laut FSPO
Examination duration and scale	wird zu Beginn der Lehrveranstaltung festgelegt
Lecturer	Dozenten des SD B
Language	DE/EN
Cycle	WiSe/SoSe
Content	The course occurs only if required. The content is defined at short notice.
Literature	Die Literatur wird kurzfristig festgelegt.

Course L2412: Special topics of Civil- and Environmental Engineering 2 LP	
Typ	
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	laut FSPO
Examination duration and scale	wird zu Beginn der Lehrveranstaltung festgelegt
Lecturer	Dozenten des SD B
Language	DE/EN
Cycle	WiSe/SoSe
Content	The course occurs only if required. The content is defined at short notice.
Literature	Die Literatur wird kurzfristig festgelegt.

Course L2413: Special topics of Civil- and Environmental Engineering 3LP	
Typ	
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Examination Form	laut FSPO
Examination duration and scale	wird zu Beginn der Lehrveranstaltung festgelegt
Lecturer	Dozenten des SD B
Language	DE/EN
Cycle	WiSe/SoSe
Content	The course occurs only if required. The content is defined at short notice.
Literature	Die Literatur wird kurzfristig festgelegt.

Course L0472: Fire Protection and Prevention	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Examination Form	Mündliche Prüfung
Examination duration and scale	20 min
Lecturer	Philipp Below, Ulrich Körner
Language	DE
Cycle	SoSe
Content	• Introduction • fire in residential and office buildings • town planning: location of residential, office and industry areas, location of fire stations • design of roads an water pipes • explosions
Literature	• Schneider U. : Ingenieurmethoden im baulichen Brandschutz. Expert Verlag, 2. Aufl., 2002

Specialization Civil Engineering

Module M0755: Geotechnics II

Courses

Title	Typ	Hrs/wk	CP
Foundation Engineering (L0552)	Lecture	2	2
Foundation Engineering (L0553)	Recitation Section (large)	2	2
Foundation Engineering (L1494)	Recitation Section (small)	2	2

Module Responsible	Prof. Jürgen Grabe
Admission Requirements	None
Recommended Previous Knowledge	Modules: • Mechanics I-II • Geotechnics I
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students know the basic principles and methods which are required to verificate the stability of geotechnical structures.
Skills	After successful completion of the module the students are able to: • verificate the stability and usability of foundations, • know individual methods of ground improvement and apply them in their range of application, • design retaining walls.
Personal Competence	
Social Competence	
Autonomy	
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	Compulsory: No; Bonus: 20 %; Form: Attestation; Description:
Examination	Written exam
Examination duration and scale	90 minutes
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0552: Foundation Engineering

Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	• Shallow foundations • Pile foundations • Ground improvement • Retaining walls • Underpinning • Groundwater Conservation • Cut-off Walls
Literature	• Vorlesung/Übung s. www.tu-harburg.de/gbt • Grabe, J. (2004): Bodenmechanik und Grundbau • Kolymbas, D. (1998): Geotechnik - Bodenmechanik und Grundbau • Grundbau-Taschenbuch, neueste Auflage

Course L0553: Foundation Engineering	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1494: Foundation Engineering	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0983: Mobility Concepts

Courses

Title	Typ	Hrs/wk	CP
Mobility Research and Transportation Projects (L1181)	Project-/problem-based Learning	3	3
Mobility in Megacities and Developing Countries (L1182)	Seminar	3	3

Module Responsible	Dr. Philine Gaffron
Admission Requirements	None
Recommended Previous Knowledge	Module Transportation Planning and Traffic Engineering
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to: • name the different urban transport systems existing around the world. • explain the transport challenges in Asian and African mega cities. • recognise and relate interactions between transport systems on the one hand and ecological, socio-cultural and economic problem areas on the other. • outline specific issues and problems in urban development and transport (in Germany and developing countries). • explain the effects of external framework factors (like energy costs) on transport.
Skills	Students are able to: • analyse and evaluate given case studies. • transfer learning results to other regions and cities. • analyse specific issues and problems in urban development and transport (in developing countries). • critically assess actors, planning objectives, planned measures and the implementation of transport projects in the light of the UN Millennium Development Goals • develop and present sustainable (i.e. ecological, poverty oriented, gender balanced and economical) solutions for urban personal and goods transport
Personal Competence	
Social Competence	Students are able to: • present and explain independently generated findings. • constructively discuss potentially controversial topics in a group context.
Autonomy	Students are able to: • carry out independent literature research and analysis. • independently author a written report on a given topic.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	Compulsory: Yes; Bonus: None; Form: Participation in excursions; Description: Exkursion innerhalb Hamburgs abhängig von aktuellen Themen im Modul
Examination	Written elaboration
Examination duration and scale	All assignments in groups (2-4 students): written report, 2000 words (incl. 2 short presentations of 10 mins.); final presentation, 20 mins. plus discussion (incl. slides) and 1000 word report incl. peer review (individual).
Assignment for the Following Curricula	Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Logistics and Mobility: Specialisation Traffic Planning and Systems: Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Compulsory

Course L1181: Mobility Research and Transportation Projects	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Dr. Philine Gaffron
Language	DE
Cycle	SoSe
Content	This course places its focus on transport and mobility in Germany. It deals with questions such as: • Which external factors - like e.g. energy costs, availability of renewable and fossil fuels, environmental and climate protection objectives - influence current developments in the transport sector? • Which external effects in turn are caused by mobility choices and traffic? • How should these interactions be evaluated, how and by whom can they be influenced? • Which measures at the municipal level can contribute to a more sustainable transport system? During the course, these questions will be illustrated and discussed with reference to different examples and current developments. Participants will also provide input on specific topics. Potential core subjects of the course could be: • Environmental Justice : which population groups are disproportionately affected by transport emissions and who causes them? • Municipal cycle planning • Transport and Climate Protection: can, want, act - everything could be, nothing must be?
Literature	Die Literaturempfehlungen sind abhängig von den jeweiligen, wechselnden Themenschwerpunkten und werden rechtzeitig vor Beginn der Veranstaltung bekannt gegeben.

Course L1182: Mobility in Megacities and Developing Countries	
Typ	Seminar
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Dr. Jürgen Perschon, Christof Hertel
Language	DE
Cycle	SoSe
Content	The course provides and overview over different transport projects in the metropolitan areas of developing countries. Considering different perspectives on urban growth, social justice, economic development, environmental and climate protection as well as the economic viability of public transport, the specific situation in the urban conglomerates of Asia, Latin America and Africa will be analysed and placed in a regional and global context. Specific public transport systems will be examined to establish, whether they are a suitable example for sustainable urban development. The following examples could be suitable case studies: Singapore (Metro), Lagos (BRT Light), Guanghzou, Bogota, Jakarta (Full BRT), Sao Paulo, Medellin (Cable Car Systems), Johannesburg (Minibus-Taxi). The course will be designed interactively with the students and will partly be in English as is the majority of the literature in this area (also: Skype online interviews with international experts in the transport sector). **An English language presentation is also part of the course work.**
Literature	--

Module M1628: Sustainable Building

Courses

Title	Typ	Hrs/wk	CP
Circular flow economy and structural recycling (L2464)	Integrated Lecture	2	2
Sustainable building materials and buildings (L3179)	Integrated Lecture	2	2
Sustainable water management and hydraulic engineering (L3180)	Integrated Lecture	2	2

Module Responsible	Prof. Peter Fröhle
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge of building materials, building chemistry, building construction and building project management
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to reproduce essential features of sustainable construction and material cycles. They can also name the constructional and environmental properties of recyclates and describe the sampling and analysis process. They are able to give an overview of the history, definition and to provide strategic approaches to the sustainability discussion from a constructional and environmental perspective. Furthermore, they can explain relevant objectives, strategies and exemplary fields of research in the field of sustainable construction (e.g. environmental impacts of the production and use of building materials, life cycle assessment, energy and climate-optimised planning and construction, material principles of renewable raw materials). Students will be able to discuss the fundamental relationship between the origin and type of construction waste, quantities produced and methods for characterising them.
Skills	Students can relate relevant legal requirements to practical problems of environmentally sound design and construction and thus justify the application of specific limit values for individual areas of application. Students are able to assess risks that may arise from hazardous construction waste in a concise manner. They are able to critically examine innovative areas of application of sustainable construction on the basis of central engineering, economic and legal criteria. They can thereafter evaluate and propose approaches for alternative solutions exemplarily, e.g. for the processing and recycling of construction waste.
Personal Competence	
Social Competence	The students are able to work out their own solutions for specific problems of recycling building materials in small groups. For this purpose, they can organise themselves in a division of labour and can give themselves a work and project plan. Furthermore, they are able to appoint group members to coordinate the cooperation with other working groups of the module and to moderate the presentation of work results in the seminar.
Autonomy	Students can coordinate their individual work performance with the other members of the group and prepare for it efficiently by use of scientific media.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	**Compulsory** **Bonus** **Form** **Description** Yes 20 % Written elaboration
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	Civil- and Environmental Engineering: Specialisation Water and Environment: Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Integrated Building Technology: Core Qualification: Compulsory

Course L2464: Circular flow economy and structural recycling

Typ	Integrated Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	DE
Cycle	SoSe
Content	• Types, origin, quantities of construction waste and building debris • Risks and characterisation of construction waste • Avoidance strategies and recycling options for construction waste and building debris • Criteria of sampling, analysis and opportunities for the use of treated building materials • political and legal requirements for the recycling of building materials
Literature	Friedrichsen, S. (2018). Nachhaltiges Planen, Bauen und Wohnen: Kriterien für Neubau und Bauen im Bestand. 2. Aufl. Berlin, Springer Müller et al. (2017). Nachhaltiges Bauen des Bundes: Grundlagen, Methoden, Werkzeuge (Schriftenreihe Zukunft Bauen, Band 08)

Course L3179: Sustainable building materials and buildings	
Typ	Integrated Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Sebastian Rybczynski
Language	DE
Cycle	SoSe
Content	
Literature	

Course L3180: Sustainable water management and hydraulic engineering	
Typ	Integrated Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	SoSe
Content	
Literature	

Module M1715: Renewable Energies

Courses

Title	Typ	Hrs/wk	CP
Fuels II (L3143)	Lecture	1	1
Renewable Energies I (L2740)	Lecture	2	2
Renewable Energies I (L2742)	Recitation Section (large)	1	1
Renewable Energies II (L2741)	Lecture	2	2

Module Responsible	Prof. Martin Kaltschmitt
Admission Requirements	None
Recommended Previous Knowledge	none
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Upon completion of this module, students will be able to provide an overview of characteristics of renewable energy systems. They will be able to explain the issues that arise in these systems. Furthermore, they are able to explain knowledge of energy supply, energy distribution and energy trading in this context, taking into account contexts bordering on specific disciplines. The students can explain this knowledge in detail for such energy systems and take a critical stand on it. Furthermore, they can explain the environmental impact of using renewable energy systems and have an overview of the economic classification of the respective options.
Skills	Students are able to apply methodologies for determining energy demand or energy supply to different types of renewable energy systems. Furthermore, they can evaluate such energy systems technically, ecologically and economically as well as systemically and also design them under certain given conditions. They are able to select the regulations necessary for this in a subject-specific manner, especially by means of non-standard solutions to a problem. Students are able to orally explain issues from the subject area and approaches to dealing with them and to classify them in the respective context.
Personal Competence	
Social Competence	Students are able to investigate suitable technical alternatives and ultimately evaluate them based on technical, economic and ecological criteria - and thus from a sustainability perspective.
Autonomy	Students will be able to independently access sources about the field, acquire knowledge and transform it to address new issues.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	150 min
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Green Technologies: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Engineering: Compulsory Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory Process Engineering: Core Qualification: Compulsory

Course L3143: Fuels II	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Karsten Wilbrand
Language	DE
Cycle	SoSe
Content	• Regulatory requirements of "alternative" fuels (e.g. RED) • Overview of today's alternative fuels o Biodiesel / HEFA o Bioethanol o Biomethane o Other fuels • Overview of future alternative fuels o 2nd generation biofuels o Hydrogen and hydrogen derivatives o Electricity-based fuels o Other fuels • Electromobility o with battery o with hydrogen fuel cell • Markets and market developments • CO2 analyses of the various options per application area • Global megatrends and future challenges • Developments in vehicle and drive technologies • Energy scenarios up to 2050 and significance for the mobility sector
Literature	Eigene Unterlagen, Veröffentlichungen, Fachliteratur Literature: Own documents, publications, technical literature

Course L2740: Renewable Energies I	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe
Content	This module includes a presentation of the renewable energy supply and a discussion of the respective technologies for providing the desired final or useful energy. Specifically, this includes the options for solar energy use for heat and power generation (i.e., passive solar energy use, solar collectors for low-temperature heat provision, solar thermal power generation, photovoltaic power generation), wind energy use for power generation (i.e. onshore and offshore wind power use), hydroelectric power use for electricity generation (i.e., run-of-river and storage hydroelectric power), ocean energy use for electricity generation (including tidal power plants), and geothermal energy use for heat and electricity generation (i.e., near-surface use by means of heat pumps, deep geothermal energy use for heat and/or electricity generation).
Literature	Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Erneuerbare Energien - Systemtechnik, Wirtschaftlichkeit, Umweltaspekte; Springer, Berlin, Heidelberg, 2020, 6. Auflage

Course L2742: Renewable Energies I	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe
Content	Students work on different tasks in the field of renewable energies. They present their solutions in the exercise lesson and discuss it with other students and the lecturer. Possible tasks in the field of renewable energies are: • Solar thermal heat • Concentrating solare power • Photovoltaic • Windenergie • Hydropower • Heat pump Deep geothermal energy
Literature	Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Erneuerbare Energien - Systemtechnik, Wirtschaftlichkeit, Umweltaspekte; Springer, Berlin, Heidelberg, 2020, 6. Auflage

Course L2741: Renewable Energies II	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe
Content	This lecture covers all options for energy supply from biomass; this includes the supply of heat, electricity and fuels. The biomass resource and its origin will be discussed first. Afterwards the biomass supply is addressed, which bridges the gap between biomass generation and utilization. Subsequently, the different conversion options are discussed. Only those options are presented in depth that have a corresponding significance on the market in Germany and Europe. This includes (a) heat generation from biogenic solid fuels in small and large-scale plants (b) power generation from solid biomass via combustion (c) a biogas production from residues, by-products and waste, (d) alcohol production from sugar and starch (e) biodiesel production from vegetable oils. Special attention is also paid to the corresponding environmental aspects. An economic classification of the various options is also provided.
Literature	Unterlagen der Vorlesung

Module M0631: Reinforced Concrete Structures II

Courses

Title	Typ	Hrs/wk	CP
Project Concrete Structures II (L0894)	Project Seminar	1	1
Concrete Structures II (L0348)	Lecture	2	3
Concrete Structures II (L0349)	Recitation Section (large)	2	2

Module Responsible	Prof. Günter Rombach
Admission Requirements	None
Recommended Previous Knowledge	• Knowledge of loads on structures and combination of actions • Basics of safety format are required. • Knowledge in design of beams and columns for ultimate limit state • Modules: Reinforced Concrete Structures I, Structural Analysis I+II, Mechanics I+II
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students know the basic principles which are required for design of reinforced concrete structures. They know the various methods to estimate the member forces in simple one and two-way slabs.
Skills	• The students can design reinforced concrete structure in the ultimate limit state (shear, bending, torsion) and in the serviceability limit state (crack and deflection control) including detailing (anchorage and links etc.). • The students can estimate the member forces of simple slabs. • The students know the content and the layout of a structural analysis
Personal Competence	
Social Competence	Cooperation in a project work, where they design in a team a real concrete building and present the results at the end.
Autonomy	Students are able to design simple reinforced concrete structures and evaluate the results.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	Compulsory: No; Bonus: None; Form: Excercises; Description:
Examination	Written exam
Examination duration and scale	120 minutes
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory

Course L0894: Project Concrete Structures II

Typ	Project Seminar
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Günter Rombach
Language	DE
Cycle	WiSe
Content	Design of a truss structure
Literature	Skript zur Lehrveranstaltung "Stahlbetonbau II"

Course L0348: Concrete Structures II	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Günter Rombach
Language	DE
Cycle	WiSe
Content	• Design of concrete members for shear, punching and torsion • Design for serviceability limit state (durability): crack- and deflection control • Detailing • Design of discontinuity regions (e.g. corbels, frame corner) • design of footings • Introduction in the design of slabs • Layout and content of a structural design
Literature	• Vorlesungsumdrucke zum downloaden im STUDiP • Zilch K., Zehetmaier G.: Bemessung im konstruktiven Betonbau. Springer Verlag, 2010 • König G., Tue N.: Grundlagen des Stahlbetonbaus. Teubner Verlag, Stuttgart 1998 • Deutscher Beton- und Bautechnikverein E.V.: Beispiele zur Bemessung von Betontragwerken nach Eurocode 2. Band 1: Hochbau, Bauverlag GmbH, Wiesbaden 2011 • Dahms K.-H.: Rohbauzeichnungen, Bewehrungszeichnungen. Bauverlag, Wiesbaden 1997 • Grasser E. ,Thielen G.: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen von Stahlbetontragwerken. Deutscher Ausschuss für Stahlbeton, Heft 240, Verlag Ernst & Sohn, Berlin 1978 • DIN EN 1992-1-1:2011: Bemessung und Konstruktion von Stahlbeton- und Spannbetontragwerken - Teil 1: Allgemeine Bemessungsregeln für den Hochbau.

Course L0349: Concrete Structures II	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Günter Rombach
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0829: Foundations of Management

Courses

Title	Typ	Hrs/wk	CP
Management Tutorial (L0882)	Recitation Section (small)	2	3
Introduction to Management (L0880)	Lecture	3	3

Module Responsible	Prof. Christoph Ihl
Admission Requirements	None
Recommended Previous Knowledge	Basic Knowledge of Mathematics and Business
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After taking this module, students know the important basics of many different areas in Business and Management, from Planning and Organisation to Marketing and Innovation, and also to Investment and Controlling. In particular they are able to • explain the differences between Economics and Management and the sub-disciplines in Management and to name important definitions from the field of Management • explain the most important aspects of and goals in Management and name the most important aspects of entreprneurial projects • describe and explain basic business functions as production, procurement and sourcing, supply chain management, organization and human ressource management, information management, innovation management and marketing • explain the relevance of planning and decision making in Business, esp. in situations under multiple objectives and uncertainty, and explain some basic methods from mathematical Finance • state basics from accounting and costing and selected controlling methods.
Skills	Students are able to analyse business units with respect to different criteria (organization, objectives, strategies etc.) and to carry out an Entrepreneurship project in a team. In particular, they are able to • analyse Management goals and structure them appropriately • analyse organisational and staff structures of companies • apply methods for decision making under multiple objectives, under uncertainty and under risk • analyse production and procurement systems and Business information systems • analyse and apply basic methods of marketing • select and apply basic methods from mathematical finance to predefined problems • apply basic methods from accounting, costing and controlling to predefined problems
Personal Competence	
Social Competence	Students are able to • work successfully in a team of students • to apply their knowledge from the lecture to an entrepreneurship project and write a coherent report on the project • to communicate appropriately and • to cooperate respectfully with their fellow students.
Autonomy	Students are able to • work in a team and to organize the team themselves • to write a report on their project.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Subject theoretical and practical work
Examination duration and scale	several written exams during the semester
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Core Qualification: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Specialisation Bio Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Engineering: Elective Compulsory Computer Science: Core Qualification: Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisation Biotechnologies: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Systems / Renewable Energies: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Maritime Technologies: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Water Technologies: Elective Compulsory Computer Science in Engineering: Core Qualification: Compulsory Integrated Building Technology: Core Qualification: Compulsory Logistics and Mobility: Core Qualification: Compulsory Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Specialisation Naval Engineering: Compulsory

	Mechatronics: Specialisation Electrical Systems: Compulsory Mechatronics: Specialisation Dynamic Systems and AI: Compulsory Mechatronics: Core Qualification: Compulsory Mechatronics: Specialisation Robot- and Machine-Systems: Compulsory Mechatronics: Specialisation Medical Engineering: Compulsory Orientation Studies: Core Qualification: Elective Compulsory Orientation Studies: Core Qualification: Elective Compulsory Naval Architecture: Core Qualification: Compulsory Technomathematics: Core Qualification: Compulsory Process Engineering: Core Qualification: Compulsory Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory

Course L0882: Management Tutorial	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christoph Ihl, Katharina Roedelius
Language	DE
Cycle	WiSe/SoSe
Content	In the management tutorial, the contents of the lecture will be deepened by practical examples and the application of the discussed tools. If there is adequate demand, a problem-oriented tutorial will be offered in parallel, which students can choose alternatively. Here, students work in groups on se selected projects that focus on the elaboration of an innovative business idea from the point of view of an established company or a startup. Again, the busin knowledge from the lecture should come to practical use. The group projects are guided by a mentor.
Literature	Relevante Literatur aus der korrespondierenden Vorlesung.

Course L0880: Introduction to Management	
Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Christoph Ihl, Prof. Christian Lüthje, Prof. Christian Ringle, Prof. Cornelius Herstatt, Prof. Kathrin Fischer, Prof. Matthias Meyer, Prof. Thomas Wrona, Prof. Thorsten Blecker, Prof. Wolfgang Kersten
Language	DE
Cycle	WiSe/SoSe
Content	• Introduction to Business and Management, Business versus Economics, relevant areas in Business and Management • Important definitions from Management, • Developing Objectives for Business, and their relation to important Business functions • Business Functions: Functions of the Value Chain, e.g. Production and Procurement, Supply Chain Management, Innovation Management, Marketing and Sales Cross-sectional Functions, e.g. Organisation, Human Ressource Management, Supply Chain Management, Information Management • Definitions as information, information systems, aspects of data security and strategic information systems • Definition and Relevance of innovations, e.g. innovation opporunities, risks etc. • Relevance of marketing, B2B vs. B2C-Marketing • different techniques from the field of marketing (e.g. scenario technique), pricing strategies • important organizational structures • basics of human ressource management • Introduction to Business Planning and the steps of a planning process • Decision Analysis: Elements of decision problems and methods for solving decision problems • Selected Planning Tasks, e.g. Investment and Financial Decisions • Introduction to Accounting: Accounting, Balance-Sheets, Costing • Relevance of Controlling and selected Controlling methods • Important aspects of Entrepreneurship projects
Literature	Bamberg, G., Coenenberg, A.: Betriebswirtschaftliche Entscheidungslehre, 14. Aufl., München 2008 Eisenführ, F., Weber, M.: Rationales Entscheiden, 4. Aufl., Berlin et al. 2003 Heinhold, M.: Buchführung in Fallbeispielen, 10. Aufl., Stuttgart 2006. Kruschwitz, L.: Finanzmathematik. 3. Auflage, München 2001. Pellens, B., Fülbier, R. U., Gassen, J., Sellhorn, T.: Internationale Rechnungslegung, 7. Aufl., Stuttgart 2008. Schweitzer, M.: Planung und Steuerung, in: Bea/Friedl/Schweitzer: Allgemeine Betriebswirtschaftslehre, Bd. 2: Führung, 9. Aufl., Stuttgart 2005. Weber, J., Schäffer, U. : Einführung in das Controlling, 12. Auflage, Stuttgart 2008. Weber, J./Weißenberger, B.: Einführung in das Rechnungswesen, 7. Auflage, Stuttgart 2006.

Module M1887: Transportation Planning and Traffic Engineering

Courses

Title	Typ	Hrs/wk	CP
Transport Planning and Traffic Engineering (L0997)	Project-/problem-based Learning	4	6

Module Responsible	Prof. Carsten Gertz
Admission Requirements	None
Recommended Previous Knowledge	None
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to • understand the facts, contexts and objectives of transport planning. • correctly apply definitions and concepts of transport planning. • reproduce basic concepts of transport modelling. • explain the fundamentals of traffic engineering and transport infrastructure construction.
Skills	Students are able to • analyse transport supply based on key metrics. • estimate transport demand using key metrics. • design transport networks, links and junctions. • calculate traffic signal plans. • assess transport concepts.
Personal Competence	
Social Competence	Students are able to • get together in groups and constructively discuss and analyse set problems. • in a group agree on solutions and document them.
Autonomy	Students are able to • produce reports on group work. • structure the tasks and timing for working out a set problem.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	Compulsory: No; Bonus: 5 %; Form: Excercises; Description:
Examination	Subject theoretical and practical work
Examination duration and scale	Project report in four work packages, in small groups, during the semester
Assignment for the Following Curricula	Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory

Course L0997: Transport Planning and Traffic Engineering	
Typ	Project-/problem-based Learning
Hrs/wk	4
CP	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Carsten Gertz
Language	DE
Cycle	WiSe
Content	The course provides an introductory overview over the fundamentals of urban and regional transport planning, including the sub-topic traffic engineering. The following subject areas are covered: • objectives of transport planning, • key mobility metrics, • measuring and predicting demand, • designing and planning transport infrastructure, • fundamentals of traffic engineering and • an introduction to transport concepts and planning processes.
Literature	Bosserhoff, Dietmar (2000) Integration von Verkehrsplanung und räumlicher Planung. Schriftenreihe der Hessischen Straßen- und Verkehrsverwaltung, Heft 42. Hessisches Landesamt für Straßen- und Verkehrswesen. Wiesbaden. Lohse, Dieter; Schnabel, Werner (2011) Grundlagen der Straßenverkehrstechnik und der Verkehrsplanung: Band 1; Straßenverkehrstechnik. Beuth Verlag. Berlin. Forschungsgesellschaft für Straßen- und Verkehrswesen (2006) Richtlinien für die Anlage von Stadtstraßen - RASt 06. FGSV-Verlag. Köln (FGSV, 200). Vallée, Dirk; Engel, Barbara; Vogt, Walter (2021) Stadtverkehrsplanung Band 3, Springer Verlag. Berlin.

Module M1843: Non-linear structural analysis

Courses

Title	Typ	Hrs/wk	CP
Non-linear structural analysis (L3041)	Lecture	2	3
Non-linear structural analysis (L3042)	Recitation Section (large)	2	2
Non-linear structural analysis (L3135)	Recitation Section (small)	1	1

Module Responsible	Prof. Bastian Oesterle
Admission Requirements	None
Recommended Previous Knowledge	• Mechanics I/II • Mathematics I/II • Differential Equations I • Structural Analysis I • Structural Analysis II
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After successful completion of this module, students can express the basic aspects of non-linear structural analysis of statically indeterminate frame structures.
Skills	After successful completion of this module, the students will be able to predict the non-linear structural response of frame structures using the appropriate computational approaches and methods.
Personal Competence	
Social Competence	Students can • participate in subject-specific and interdisciplinary discussions, • defend their own work results in front of others • promote the scientific development of colleagues • Furthermore, they can give and accept professional constructive criticism
Autonomy	Students are able to gain knowledge of the subject area from given and other sources and apply it to new problems. Furthermore, they are able to structure the solution process for problems in the area of nonlinear structural analysis.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory

Course L3041: Non-linear structural analysis	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Bastian Oesterle
Language	DE
Cycle	WiSe
Content	The module ist structured into three main parts, namely 1. geometrically non-linear methods, 2. pre-stressed systems and 3. material non-linear methods. The topic pre-steressed systems contains both geometrically non-linear phenomena (e.g. geometrical or initial stress stiffness of pre-stressed cables) and material non-linear phenomena (e.g. failure of concrete under tensile stresses). In all three parts, first the phenomena are described, followed by the derivation of corresponding model and computational methods. The topics cover: **Part 1: Geometrically non-linear methods** • geometrically non-linear structural behaviour • force and displacement load cases • equilibrium in the deformed configuration • geometrical stiffness • second order theory • displacement method and direct stiffness method considering second order theory • stability analysis • bifurcation problems and snap-through problems **Part 2: Pre-stressed systems** • basic principle of pre-stressing • internal and external pre-stress • compressive pre-stress • pre-stressed concrete • tensile pre-stress, cables and membranes **Part 3: Material non-linear methods** • non-linear material behaviour • loading and unloading, self-stressed states • theory of plasticity • plastic hinge theory • ultimate limit states
Literature	• Vorlesungsmanuskript • Bletzinger et al.: Aufgabensammlung zur Baustatik: Übungsaufgaben zur Berechnung ebener Stabtragwerke. Hanser. • Dinkler: Grundlagen der Baustatik. Springer. • Marti: Baustatik. Ernst und Sohn.

Course L3042: Non-linear structural analysis	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Bastian Oesterle
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L3135: Non-linear structural analysis	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Bastian Oesterle
Language	DE
Cycle	WiSe
Content	The module ist structured into three main parts, namely 1. geometrically non-linear methods, 2. pre-stressed systems and 3. material non-linear methods. The topic pre-steressed systems contains both geometrically non-linear phenomena (e.g. geometrical or initial stress stiffness of pre-stressed cables) and material non-linear phenomena (e.g. failure of concrete under tensile stresses). In all three parts, first the phenomena are described, followed by the derivation of corresponding model and computational methods. The topics cover: **Part 1: Geometrically non-linear methods** • geometrically non-linear structural behaviour • force and displacement load cases • equilibrium in the deformed configuration • geometrical stiffness • second order theory • displacement method and direct stiffness method considering second order theory • stability analysis • bifurcation problems and snap-through problems **Part 2: Pre-stressed systems** • basic principle of pre-stressing • internal and external pre-stress • compressive pre-stress • pre-stressed concrete • tensile pre-stress, cables and membranes **Part 3: Material non-linear methods** • non-linear material behaviour • loading and unloading, self-stressed states • theory of plasticity • plastic hinge theory • ultimate limit states
Literature	• Vorlesungsmanuskript • Bletzinger et al.: Aufgabensammlung zur Baustatik: Übungsaufgaben zur Berechnung ebener Stabtragwerke. Hanser. • Dinkler: Grundlagen der Baustatik. Springer. • Marti: Baustatik. Ernst und Sohn.

Module M0612: Steel Structures II

Courses

Title	Typ	Hrs/wk	CP
Steel Structures II (L0301)	Lecture	2	3
Steel Structures II (L0302)	Recitation Section (large)	2	3

Module Responsible	Prof. Marcus Rutner
Admission Requirements	None
Recommended Previous Knowledge	Steel Structures I
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After successful completition students can • describe and explain the behaviour of bolted and welded connections • design and check simple halls and buildings • calculate forces and stresses of simple structures (trusses, beams, frames) • illustrate and dimension he main details (framework, column base, load application points)
Skills	Students are able to design simple structures and connections, describe the load distribution and recognize the possible modes of failure. They can apply structural imperfections, calculate according to 2nd order theory and verify their results.
Personal Competence	
Social Competence	--
Autonomy	--
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	120 minutes
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory

Course L0301: Steel Structures II

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	SoSe

Content	• Welded connections
	• Simple constructions
	  ◦ Trusses
	  ◦ Plate girders
	  ◦ Frames
	  ◦ Columns
	• Buildings with several storeys
	• Halls

Literature	Petersen, C.: Stahlbau, 4. Auflage 2013, Springer-Vieweg Verlag Wagenknecht, G.: Stahlbau-Praxis nach Eurocode 3, Bauwerk-Verlag 2011 • Band 1 Tragwerksplanung, Grundlagen • Band 2 Verbindungen und Konstruktionen

Course L0302: Steel Structures II

Typ	Recitation Section (large)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1634: Computational Structural Mechanics

Courses

Title	Typ	Hrs/wk	CP
Computational Stuctural Mechanics (L2475)	Integrated Lecture	2	2
Computational Structural Mechanics (Exercise) (L2873)	Recitation Section (small)	1	1

Module Responsible	Prof. Christian Cyron
Admission Requirements	None
Recommended Previous Knowledge	Engineering Mechanics I, Engineering Mechanics II, Mathematics I, Mathematics II
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students now commonly used models for linear and planar structures in structural mechanics. Moreover, they understand the importance of computational methods in modern solid mechanics and in particular also the theoretical foundations of the finite element method.
Skills	Students are able to develop simple computational methods and programs to solve problems in solid mechanics. Moreover, student have sufficient basic knowledge about the finite element method to use commercial software in this area for the successful solution of at least simple problems (after a short introduction into the handling of a specific software package).
Personal Competence	
Social Competence	Students are capable to communicate and work out complex problems and their solutions with professional staff.
Autonomy	The students are able to assess their own strengths and weaknesses. They can independently and on their own identify and solve problems in the area of Computational Structural Mechanic and acquire the knowledge required to this end.
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Credit points	3
Course achievement	None
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Compulsory

Course L2475: Computational Stuctural Mechanics

Typ	Integrated Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	SoSe
Content	The lecture Computational Structural Mechanics extends the content of the lecture Engineering Mechanic II. It bridges the gap between the manual calculation of mechanical stress and deformation in systems with a particularly simple geometry and the efficent computer-based computation of general mechanical systems: • Basics of linear continuum mechanics • Planar structures: plate, membrane, slab • Linientragwerke: beam, cable, truss • Weak form and Galerkin's method • Finite element method: theory and application • Principles of mechanics: principle of virtual work, virtual displacements, virtual forces
Literature	Gross, Hauger, Wriggers, "Technische Mechanik 4", Springer

Course L2873: Computational Structural Mechanics (Exercise)

Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Christian Cyron
Language	DE
Cycle	SoSe
Content	The exercise on Computational Structural Mechanics demonstrates how the theoretical content of the lecture on Computational Structural Mechanics can be applied to solve specific mechanical problems.
Literature	

Module M1633: Planning Law and Environmental Law/ Sustainable Urban Development

Courses

Title	Typ	Hrs/wk	CP
Sustainable Urban Development (L2474)	Lecture	2	3
Planning law and Environmental law (L2473)	Lecture	2	3

Module Responsible	Prof. Ralf Otterpohl
Admission Requirements	None
Recommended Previous Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence *Knowledge* *Skills* **Personal Competence** *Social Competence* *Autonomy*	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Subject theoretical and practical work
Examination duration and scale	Written-theoretical part and report
Assignment for the Following Curricula	Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory

Course L2474: Sustainable Urban Development

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Irene Peters
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2473: Planning law and Environmental law

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Martin Wickel
Language	DE
Cycle	SoSe
Content	
Literature	

Module M0985: Introduction to Railways

Courses

Title	Typ	Hrs/wk	CP
Introduction to Railways (L1184)	Lecture	2	4
Introduction to Railways (L1185)	Recitation Section (large)	1	2

Module Responsible	Prof. Carsten Gertz
Admission Requirements	None
Recommended Previous Knowledge	none
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can... • give definitions for basic terms related to railways • explain specifics concerning the handling of goods on railways • explain the required infrastructure • describe the work at the track super structure
Skills	--
Personal Competence	
Social Competence	Students can... • work at tasks in groups and come to results together • discuss contents in groups, summarize them and present them in front of others • convey contents to other by processing them in writing
Autonomy	Students can work out and understand contents themselves during the lecture through literature research
Workload in Hours	Independent Study Time 138, Study Time in Lecture 42
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory

Course L1184: Introduction to Railways

Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	André Schoppe
Language	DE
Cycle	SoSe
Content	Lecture: The module provides a basic knowledge of the field of railroad engineering. An overview of railroad operations, control and safety technology, railroad superstructure, structural engineering, project management as well as maintenance and design of infrastructure facilities is given. The aim of this module is to give students as much insight as possible into railroad infrastructure. The module is examined by means of a written exam at the end of the semester. Lecture Hall Exercise: In order to give the students practical examples, full-day practical excursions are carried out. New handling techniques and currently available hardware will be presented by visiting the marshalling yard "die Zugbildungsanlage Maschen (ZBA)". Furthermore, the training center for track construction and civil engineering as well as the operations center in Hanover will be visited, where facilities and tasks will be presented. Questionnaires will also be provided for practice purposes. In addition, study papers can be handed out and supervised as required.
Literature	Die maßgebliche Literatur wird in StudIP veröffentlicht. Weitere Hinweise werden in der Veranstaltung gegeben.

Course L1185: Introduction to Railways	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	André Schoppe
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1632: Applied Water Management

Courses

Title	Typ	Hrs/wk	CP
Nature-oriented Hydraulic Engineering (L2472)	Project-/problem-based Learning	2	2
Numerical modelling of soil water dynamics (L2471)	Project-/problem-based Learning	2	2
Numerical modelling of soil water dynamics (L2470)	Lecture	2	2

Module Responsible	Prof. Peter Fröhle
Admission Requirements	None
Recommended Previous Knowledge	• Basic knowledge of analysis and differential equations • hydromechanical and hydraulic engineering principles
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to define the basic tasks and terms of nature-oriented hydraulic engineering und groundwater hydrology. They cam describe the basics concepts, the basic approaches and methods of nature-oriented hydraulic engineering, groundwater hydrology and groundwater modelling and are able to apply these to practical problems.
Skills	The students are able to apply the methods and approaches of nature-oriented hydraulic engineering and of groundwater hydrology to practical problems. They can demonstrate to transfer and apply these to simple hydraulic engineering systems. In addition, they are able to apply the approaches commonly used in groundwater hydrology. They can exemplarily explain and reason how to apply them as a basis for geo-hydrological questions. In addition, students can apply basic groundwater modelling methods to simple problems of groundwater movement and groundwater recharge.
Personal Competence	
Social Competence	Students are able to help each other solving case studies. The students are able to deploy their gained knowledge in applied problems of the practical nature-based hydraulic engineering. Additionaly, they will be able to demonstrate to work cooperatively in teams consisting of engineers from different subject areas.
Autonomy	The students will be able to independently extend their knowledge and apply it to new problems.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Subject theoretical and practical work
Examination duration and scale	Written-theoretical part and modeling
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Water and Environmental Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Water Technologies: Elective Compulsory

Course L2472: Nature-oriented Hydraulic Engineering

Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	SoSe
Content	• Regime-theory and application for the development of environmental guiding priciples of rivers • Engineering-biological measures for the stabilization of rivers • design techniques for water engineering • hydraulic dimensioning of river bed and bank protection • design principles and design techniques for fish passages (fish ladder, ramps etc.)
Literature	

Course L2471: Numerical modelling of soil water dynamics

Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Hannes Nevermann
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L2470: Numerical modelling of soil water dynamics	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Milad Aminzadeh
Language	EN
Cycle	SoSe
Content	• Hydrologic water bilance • aquifertyps • groundwater velocities • Darcy law • groundwater contour lines • storage capacity • flow equation • pumping tests • method of Beyer • solute transport in groundwater • Basics and theoretical background of simulation methods for the analysis of water movement in vadose zone • groundwater recharge
Literature	Todd, K. (2005): Groundwater Hydrology Fetter, C. W. (2001): Applied Hydrogeology Hölting, B. & Coldewey, W. (2005): Hydrogeologie Charbeneau, R. J. (2000): Groundwater Hydraulics and pollutant Transport

Module M1723: Building Information Modeling

Courses

Title	Typ	Hrs/wk	CP
Building Information Modeling (L2760)	Integrated Lecture	2	2
Building Information Modeling (L2761)	Recitation Section (small)	2	4

Module Responsible	Prof. Kay Smarsly
Admission Requirements	None
Recommended Previous Knowledge	None
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The contents of this module follow the recommendations of the German Association of Computing in Civil Engineering (www.gacce.de) for the BIM courses taught at German universities in the subject area of engineering informatics. The module aims to present methodological knowledge to enable students to introduce, to design, to monitor, and to improve BIM processes in companies and public institutions. An in-depth understanding of the methods and technologies relevant to BIM is essential. Emphasis is placed on generally valid principles and techniques independent of specific software products and valid for several decades. The theoretical content taught in the lecture is complemented by practical exercises, in which state-of-the-art software tools will be used. Topics include computer-aided design and geometry modeling, digital modeling of buildings and infrastructure, BIM data exchange and cooperation (focusing on Industry Foundation Classes), process modeling, job descriptions and BIM applications, BIM tools, and advanced aspects. A central component of this module will be a project work.
Skills	
Personal Competence	
Social Competence	
Autonomy	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and scale	Description of a BIM model with 15-minute oral presentation
Assignment for the Following Curricula	Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory

Course L2760: Building Information Modeling

Typ	Integrated Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kay Smarsly
Language	DE
Cycle	SoSe
Content	• Historical development • Introduction and motivation • Basics of geometry • 2D geometry modeling • 2½D geometry modeling • 3D geometry modeling • Digital modeling of buildings and infrastructure, object-oriented, semantic, and parametric modeling • Data exchange, interoperability, and communication (with emphasis on Industry Foundation Classes) • BIM data storage and data management • Process modeling • Job profiles and applications • BIM tools • Advanced aspects of BIM • Seminar by external BIM experts and project presentations
Literature	

Course L2761: Building Information Modeling

Typ	Recitation Section (small)
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Kay Smarsly
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1630: Sanitary Engineering II

Courses

Title	Typ	Hrs/wk	CP
Management of Wastewater Infrastructure (L2467)	Seminar	2	3
Drinking Water Treatment (L2466)	Seminar	2	3

Module Responsible	Prof. Mathias Ernst
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge in the field of drinking water supply and waste water disposal.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can examplify their expert knowledge on drinking water, waste water treatment and the associated infrastructure systems. They are capable of reproducing the relevant empiricals assumptions and scientific simplifcations in detail. The students can model some processes mathematically. They can also assess existing problems in the field of sanitary engineering, such as removal of nitrate, and place them in a socio-political context. Furthermore, they know how to draft the features and effectiveness of important technologies of the future such as high- and low-pressure membrane filtration systems and techniques.
Skills	The students are able to apply the relevant standards and guidelines for the design and operation of urban water infrastructures independently. Their expertise comprises expert skills to design drinking water supply and urban drainage systems as well as the associated treatment facilities. Besides the acquirement of technical skills the students are able to address and solve biochemical problems in the filed of drinking water and wastewater treatment. The students are also able to develop ideas of their own to improve the existing water related infrastructures, systems and concepts.
Personal Competence	
Social Competence	The students are able to develop a specific topic in a team and to work out milestones according to a given plan.
Autonomy	Students are in a position to work on a subject and to organize their work flow independently. They can also present on this subject.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Subject theoretical and practical work
Examination duration and scale	Written-theoretical part and modelling
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Water and Environmental Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Water Technologies: Elective Compulsory

Course L2467: Management of Wastewater Infrastructure

Typ	Seminar
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	DE
Cycle	SoSe
Content	The seminar ""Infrastructure Management Wastewater"" develops the understanding of infrastructure systems in relation to wastewater systems, but also addresses other infrastructure systems. Initially, an overview of the entire system is given, including water catchment areas, water distribution, the origin of wastewater in households and industry, stormwater runoff management, and the treatment and reuse of water (constituents). Thereby the design tools especially of digital modelling are understood by practical application. Energetic considerations as well as planning and restoration of pipeline systems are covered. For wastewater treatment, the basis developed in Sanitary Engineering I will be deepened and significantly expanded, especially the resource recovery of nutrients and water. Sanitary solutions for different socio-economic and climatic conditions are understood and calculated.
Literature	Gujer, W. (2007): Siedlungswasserwirtschaft, Springer, Berlin Heidelberg Metcalf and Eddy (2003): Wastewater Engineering : Treatment and Reuse, Boston, McGraw-Hill Henze, M. (1997): Wastewater Treatment : Biological and Chemical Processes, Berlin, Springer Stein D., Stein R. (2014): Instandhaltung von Kanalisationen, Verlag Prof. Dr.-Ing. Stein & Partner GmbH Wossog, G. (2016): Handbuch für den Rohrleitungsbau Band 1 und 2 Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (2009): Abwasserableitung : Bemessungsgrundlagen, Regenwasserbewirtschaftung, Fremdwasser, Netzsanierung, Grundstücksentwässerung, Weimar, Univ.-Verl. DWA Arbeitsblätter

Course L2466: Drinking Water Treatment	
Typ	Seminar
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Mathias Ernst, Dr. Klaus Johannsen
Language	DE
Cycle	SoSe
Content	The seminar deepens and expands the knowledge of the processes of drinking water treatment. The seminar deals with ion exchange, oxidation, disinfection, gas exchange and hybrid treatment processes. Further topics include pH adjustment and energy efficiency in water supply. Within the scope of the course, the students work out a seminar performance (presentation, design, modelling) on the basis of a task.
Literature	Worch, E. (2019): Drinking Water Treatment, De Gruyter-Verlag Worch, E. (2015): Hydrochemistry, De Gruyter-Verlag Jekel, M., Czekalla, C. (2016): Wasseraufbereitung - Grundlagen und Verfahren (DVGW Lehr- und Handbuch Wasserversorgung, Band 6), DIV Deutscher Industrieverlag

Specialization Traffic and Mobility

Module M0983: Mobility Concepts

Courses

Title	Typ	Hrs/wk	CP
Mobility Research and Transportation Projects (L1181)	Project-/problem-based Learning	3	3
Mobility in Megacities and Developing Countries (L1182)	Seminar	3	3

Module Responsible	Dr. Philine Gaffron
Admission Requirements	None
Recommended Previous Knowledge	Module Transportation Planning and Traffic Engineering
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to: • name the different urban transport systems existing around the world. • explain the transport challenges in Asian and African mega cities. • recognise and relate interactions between transport systems on the one hand and ecological, socio-cultural and economic problem areas on the other. • outline specific issues and problems in urban development and transport (in Germany and developing countries). • explain the effects of external framework factors (like energy costs) on transport.
Skills	Students are able to: • analyse and evaluate given case studies. • transfer learning results to other regions and cities. • analyse specific issues and problems in urban development and transport (in developing countries). • critically assess actors, planning objectives, planned measures and the implementation of transport projects in the light of the UN Millennium Development Goals • develop and present sustainable (i.e. ecological, poverty oriented, gender balanced and economical) solutions for urban personal and goods transport
Personal Competence	
Social Competence	Students are able to: • present and explain independently generated findings. • constructively discuss potentially controversial topics in a group context.
Autonomy	Students are able to: • carry out independent literature research and analysis. • independently author a written report on a given topic.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6

Course achievement

Compulsory	Bonus	Form	Description
Yes	None	Participation in excursions	Exkursion innerhalb Hamburgs abhängig von aktuellen Themen im Modul

Examination	Written elaboration
Examination duration and scale	All assignments in groups (2-4 students): written report, 2000 words (incl. 2 short presentations of 10 mins.); final presentation, 20 mins. plus discussion (incl. slides) and 1000 word report incl. peer review (individual).
Assignment for the Following Curricula	Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Logistics and Mobility: Specialisation Traffic Planning and Systems: Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Compulsory

Course L1181: Mobility Research and Transportation Projects	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Dr. Philine Gaffron
Language	DE
Cycle	SoSe
Content	This course places its focus on transport and mobility in Germany. It deals with questions such as: • Which external factors - like e.g. energy costs, availability of renewable and fossil fuels, environmental and climate protection objectives - influence current developments in the transport sector? • Which external effects in turn are caused by mobility choices and traffic? • How should these interactions be evaluated, how and by whom can they be influenced? • Which measures at the municipal level can contribute to a more sustainable transport system? During the course, these questions will be illustrated and discussed with reference to different examples and current developments. Participants will also provide input on specific topics. Potential core subjects of the course could be: • Environmental Justice : which population groups are disproportionately affected by transport emissions and who causes them? • Municipal cycle planning • Transport and Climate Protection: can, want, act - everything could be, nothing must be?
Literature	Die Literaturempfehlungen sind abhängig von den jeweiligen, wechselnden Themenschwerpunkten und werden rechtzeitig vor Beginn der Veranstaltung bekannt gegeben.

Course L1182: Mobility in Megacities and Developing Countries	
Typ	Seminar
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Dr. Jürgen Perschon, Christof Hertel
Language	DE
Cycle	SoSe
Content	The course provides and overview over different transport projects in the metropolitan areas of developing countries. Considering different perspectives on urban growth, social justice, economic development, environmental and climate protection as well as the economic viability of public transport, the specific situation in the urban conglomerates of Asia, Latin America and Africa will be analysed and placed in a regional and global context. Specific public transport systems will be examined to establish, whether they are a suitable example for sustainable urban development. The following examples could be suitable case studies: Singapore (Metro), Lagos (BRT Light), Guanghzou, Bogota, Jakarta (Full BRT), Sao Paulo, Medellin (Cable Car Systems), Johannesburg (Minibus-Taxi). The course will be designed interactively with the students and will partly be in English as is the majority of the literature in this area (also: Skype online interviews with international experts in the transport sector). **An English language presentation is also part of the course work.**
Literature	--

Module M0755: Geotechnics II

Courses

Title	Typ	Hrs/wk	CP
Foundation Engineering (L0552)	Lecture	2	2
Foundation Engineering (L0553)	Recitation Section (large)	2	2
Foundation Engineering (L1494)	Recitation Section (small)	2	2

Module Responsible	Prof. Jürgen Grabe
Admission Requirements	None
Recommended Previous Knowledge	Modules: • Mechanics I-II • Geotechnics I
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students know the basic principles and methods which are required to verificate the stability of geotechnical structures.
Skills	After successful completion of the module the students are able to: • verificate the stability and usability of foundations, • know individual methods of ground improvement and apply them in their range of application, • design retaining walls.
Personal Competence	
Social Competence	
Autonomy	
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	Compulsory: No; Bonus: 20 %; Form: Attestation; Description:
Examination	Written exam
Examination duration and scale	90 minutes
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0552: Foundation Engineering

Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	• Shallow foundations • Pile foundations • Ground improvement • Retaining walls • Underpinning • Groundwater Conservation • Cut-off Walls
Literature	• Vorlesung/Übung s. www.tu-harburg.de/gbt • Grabe, J. (2004): Bodenmechanik und Grundbau • Kolymbas, D. (1998): Geotechnik - Bodenmechanik und Grundbau • Grundbau-Taschenbuch, neueste Auflage

Course L0553: Foundation Engineering

Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1494: Foundation Engineering	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1628: Sustainable Building

Courses

Title	Typ	Hrs/wk	CP
Circular flow economy and structural recycling (L2464)	Integrated Lecture	2	2
Sustainable building materials and buildings (L3179)	Integrated Lecture	2	2
Sustainable water management and hydraulic engineering (L3180)	Integrated Lecture	2	2

Module Responsible	Prof. Peter Fröhle
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge of building materials, building chemistry, building construction and building project management
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to reproduce essential features of sustainable construction and material cycles. They can also name the constructional and environmental properties of recyclates and describe the sampling and analysis process. They are able to give an overview of the history, definition and to provide strategic approaches to the sustainability discussion from a constructional and environmental perspective. Furthermore, they can explain relevant objectives, strategies and exemplary fields of research in the field of sustainable construction (e.g. environmental impacts of the production and use of building materials, life cycle assessment, energy and climate-optimised planning and construction, material principles of renewable raw materials). Students will be able to discuss the fundamental relationship between the origin and type of construction waste, quantities produced and methods for characterising them.
Skills	Students can relate relevant legal requirements to practical problems of environmentally sound design and construction and thus justify the application of specific limit values for individual areas of application. Students are able to assess risks that may arise from hazardous construction waste in a concise manner. They are able to critically examine innovative areas of application of sustainable construction on the basis of central engineering, economic and legal criteria. They can thereafter evaluate and propose approaches for alternative solutions exemplarily, e.g. for the processing and recycling of construction waste.
Personal Competence	
Social Competence	The students are able to work out their own solutions for specific problems of recycling building materials in small groups. For this purpose, they can organise themselves in a division of labour and can give themselves a work and project plan. Furthermore, they are able to appoint group members to coordinate the cooperation with other working groups of the module and to moderate the presentation of work results in the seminar.
Autonomy	Students can coordinate their individual work performance with the other members of the group and prepare for it efficiently by use of scientific media.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	**Compulsory** **Bonus** **Form** **Description** Yes 20 % Written elaboration
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	Civil- and Environmental Engineering: Specialisation Water and Environment: Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Integrated Building Technology: Core Qualification: Compulsory

Course L2464: Circular flow economy and structural recycling

Typ	Integrated Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	DE
Cycle	SoSe
Content	• Types, origin, quantities of construction waste and building debris • Risks and characterisation of construction waste • Avoidance strategies and recycling options for construction waste and building debris • Criteria of sampling, analysis and opportunities for the use of treated building materials • political and legal requirements for the recycling of building materials
Literature	Friedrichsen, S. (2018). Nachhaltiges Planen, Bauen und Wohnen: Kriterien für Neubau und Bauen im Bestand. 2. Aufl. Berlin, Springer Müller et al. (2017). Nachhaltiges Bauen des Bundes: Grundlagen, Methoden, Werkzeuge (Schriftenreihe Zukunft Bauen, Band 08)

Course L3179: Sustainable building materials and buildings	
Typ	Integrated Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Sebastian Rybczynski
Language	DE
Cycle	SoSe
Content	
Literature	

Course L3180: Sustainable water management and hydraulic engineering	
Typ	Integrated Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	SoSe
Content	
Literature	

Module M1715: Renewable Energies

Courses

Title	Typ	Hrs/wk	CP
Fuels II (L3143)	Lecture	1	1
Renewable Energies I (L2740)	Lecture	2	2
Renewable Energies I (L2742)	Recitation Section (large)	1	1
Renewable Energies II (L2741)	Lecture	2	2

Module Responsible	Prof. Martin Kaltschmitt
Admission Requirements	None
Recommended Previous Knowledge	none
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Upon completion of this module, students will be able to provide an overview of characteristics of renewable energy systems. They will be able to explain the issues that arise in these systems. Furthermore, they are able to explain knowledge of energy supply, energy distribution and energy trading in this context, taking into account contexts bordering on specific disciplines. The students can explain this knowledge in detail for such energy systems and take a critical stand on it. Furthermore, they can explain the environmental impact of using renewable energy systems and have an overview of the economic classification of the respective options.
Skills	Students are able to apply methodologies for determining energy demand or energy supply to different types of renewable energy systems. Furthermore, they can evaluate such energy systems technically, ecologically and economically as well as systemically and also design them under certain given conditions. They are able to select the regulations necessary for this in a subject-specific manner, especially by means of non-standard solutions to a problem. Students are able to orally explain issues from the subject area and approaches to dealing with them and to classify them in the respective context.
Personal Competence	
Social Competence	Students are able to investigate suitable technical alternatives and ultimately evaluate them based on technical, economic and ecological criteria - and thus from a sustainability perspective.
Autonomy	Students will be able to independently access sources about the field, acquire knowledge and transform it to address new issues.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	150 min
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Green Technologies: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Engineering: Compulsory Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory Process Engineering: Core Qualification: Compulsory

Course L3143: Fuels II	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Karsten Wilbrand
Language	DE
Cycle	SoSe
Content	• Regulatory requirements of "alternative" fuels (e.g. RED) • Overview of today's alternative fuels o Biodiesel / HEFA o Bioethanol o Biomethane o Other fuels • Overview of future alternative fuels o 2nd generation biofuels o Hydrogen and hydrogen derivatives o Electricity-based fuels o Other fuels • Electromobility o with battery o with hydrogen fuel cell • Markets and market developments • CO2 analyses of the various options per application area • Global megatrends and future challenges • Developments in vehicle and drive technologies • Energy scenarios up to 2050 and significance for the mobility sector
Literature	Eigene Unterlagen, Veröffentlichungen, Fachliteratur Literature: Own documents, publications, technical literature

Course L2740: Renewable Energies I	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe
Content	This module includes a presentation of the renewable energy supply and a discussion of the respective technologies for providing the desired final or useful energy. Specifically, this includes the options for solar energy use for heat and power generation (i.e., passive solar energy use, solar collectors for low-temperature heat provision, solar thermal power generation, photovoltaic power generation), wind energy use for power generation (i.e. onshore and offshore wind power use), hydroelectric power use for electricity generation (i.e., run-of-river and storage hydroelectric power), ocean energy use for electricity generation (including tidal power plants), and geothermal energy use for heat and electricity generation (i.e., near-surface use by means of heat pumps, deep geothermal energy use for heat and/or electricity generation).
Literature	Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Erneuerbare Energien - Systemtechnik, Wirtschaftlichkeit, Umweltaspekte; Springer, Berlin, Heidelberg, 2020, 6. Auflage

Course L2742: Renewable Energies I	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe
Content	Students work on different tasks in the field of renewable energies. They present their solutions in the exercise lesson and discuss it with other students and the lecturer. Possible tasks in the field of renewable energies are: • Solar thermal heat • Concentrating solare power • Photovoltaic • Windenergie • Hydropower • Heat pump Deep geothermal energy
Literature	Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Erneuerbare Energien - Systemtechnik, Wirtschaftlichkeit, Umweltaspekte; Springer, Berlin, Heidelberg, 2020, 6. Auflage

Course L2741: Renewable Energies II	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe
Content	This lecture covers all options for energy supply from biomass; this includes the supply of heat, electricity and fuels. The biomass resource and its origin will be discussed first. Afterwards the biomass supply is addressed, which bridges the gap between biomass generation and utilization. Subsequently, the different conversion options are discussed. Only those options are presented in depth that have a corresponding significance on the market in Germany and Europe. This includes (a) heat generation from biogenic solid fuels in small and large-scale plants (b) power generation from solid biomass via combustion (c) a biogas production from residues, by-products and waste, (d) alcohol production from sugar and starch (e) biodiesel production from vegetable oils. Special attention is also paid to the corresponding environmental aspects. An economic classification of the various options is also provided.
Literature	Unterlagen der Vorlesung

Module M0631: Reinforced Concrete Structures II

Courses

Title	Typ	Hrs/wk	CP
Project Concrete Structures II (L0894)	Project Seminar	1	1
Concrete Structures II (L0348)	Lecture	2	3
Concrete Structures II (L0349)	Recitation Section (large)	2	2

Module Responsible	Prof. Günter Rombach
Admission Requirements	None
Recommended Previous Knowledge	• Knowledge of loads on structures and combination of actions • Basics of safety format are required. • Knowledge in design of beams and columns for ultimate limit state • Modules: Reinforced Concrete Structures I, Structural Analysis I+II, Mechanics I+II
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students know the basic principles which are required for design of reinforced concrete structures. They know the various methods to estimate the member forces in simple one and two-way slabs.
Skills	• The students can design reinforced concrete structure in the ultimate limit state (shear, bending, torsion) and in the serviceability limit state (crack and deflection control) including detailing (anchorage and links etc.). • The students can estimate the member forces of simple slabs. • The students know the content and the layout of a structural analysis
Personal Competence	
Social Competence	Cooperation in a project work, where they design in a team a real concrete building and present the results at the end.
Autonomy	Students are able to design simple reinforced concrete structures and evaluate the results.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	**Compulsory** / **Bonus** / **Form** / **Description**: No / None / Excercises
Examination	Written exam
Examination duration and scale	120 minutes
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory

Course L0894: Project Concrete Structures II

Typ	Project Seminar
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Günter Rombach
Language	DE
Cycle	WiSe
Content	Design of a truss structure
Literature	Skript zur Lehrveranstaltung "Stahlbetonbau II"

Course L0348: Concrete Structures II	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Günter Rombach
Language	DE
Cycle	WiSe
Content	• Design of concrete members for shear, punching and torsion • Design for serviceability limit state (durability): crack- and deflection control • Detailing • Design of discontinuity regions (e.g. corbels, frame corner) • design of footings • Introduction in the design of slabs • Layout and content of a structural design
Literature	• Vorlesungsumdrucke zum downloaden im STUDiP • Zilch K., Zehetmaier G.: Bemessung im konstruktiven Betonbau. Springer Verlag, 2010 • König G., Tue N.: Grundlagen des Stahlbetonbaus. Teubner Verlag, Stuttgart 1998 • Deutscher Beton- und Bautechnikverein E.V.: Beispiele zur Bemessung von Betontragwerken nach Eurocode 2. Band 1: Hochbau, Bauverlag GmbH, Wiesbaden 2011 • Dahms K.-H.: Rohbauzeichnungen, Bewehrungszeichnungen. Bauverlag, Wiesbaden 1997 • Grasser E. ,Thielen G.: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen von Stahlbetontragwerken. Deutscher Ausschuss für Stahlbeton, Heft 240, Verlag Ernst & Sohn, Berlin 1978 • DIN EN 1992-1-1:2011: Bemessung und Konstruktion von Stahlbeton- und Spannbetontragwerken - Teil 1: Allgemeine Bemessungsregeln für den Hochbau.

Course L0349: Concrete Structures II	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Günter Rombach
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0829: Foundations of Management

Courses

Title	Typ	Hrs/wk	CP
Management Tutorial (L0882)	Recitation Section (small)	2	3
Introduction to Management (L0880)	Lecture	3	3

Module Responsible	Prof. Christoph Ihl
Admission Requirements	None
Recommended Previous Knowledge	Basic Knowledge of Mathematics and Business
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After taking this module, students know the important basics of many different areas in Business and Management, from Planning and Organisation to Marketing and Innovation, and also to Investment and Controlling. In particular they are able to • explain the differences between Economics and Management and the sub-disciplines in Management and to name important definitions from the field of Management • explain the most important aspects of and goals in Management and name the most important aspects of entreprneurial projects • describe and explain basic business functions as production, procurement and sourcing, supply chain management, organization and human ressource management, information management, innovation management and marketing • explain the relevance of planning and decision making in Business, esp. in situations under multiple objectives and uncertainty, and explain some basic methods from mathematical Finance • state basics from accounting and costing and selected controlling methods.
Skills	Students are able to analyse business units with respect to different criteria (organization, objectives, strategies etc.) and to carry out an Entrepreneurship project in a team. In particular, they are able to • analyse Management goals and structure them appropriately • analyse organisational and staff structures of companies • apply methods for decision making under multiple objectives, under uncertainty and under risk • analyse production and procurement systems and Business information systems • analyse and apply basic methods of marketing • select and apply basic methods from mathematical finance to predefined problems • apply basic methods from accounting, costing and controlling to predefined problems
Personal Competence	
Social Competence	Students are able to • work successfully in a team of students • to apply their knowledge from the lecture to an entrepreneurship project and write a coherent report on the project • to communicate appropriately and • to cooperate respectfully with their fellow students.
Autonomy	Students are able to • work in a team and to organize the team themselves • to write a report on their project.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Subject theoretical and practical work
Examination duration and scale	several written exams during the semester
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Core Qualification: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Specialisation Bio Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Engineering: Elective Compulsory Computer Science: Core Qualification: Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisation Biotechnologies: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Systems / Renewable Energies: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Maritime Technologies: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Water Technologies: Elective Compulsory Computer Science in Engineering: Core Qualification: Compulsory Integrated Building Technology: Core Qualification: Compulsory Logistics and Mobility: Core Qualification: Compulsory Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Specialisation Naval Engineering: Compulsory

	Mechatronics: Specialisation Electrical Systems: Compulsory Mechatronics: Specialisation Dynamic Systems and AI: Compulsory Mechatronics: Core Qualification: Compulsory Mechatronics: Specialisation Robot- and Machine-Systems: Compulsory Mechatronics: Specialisation Medical Engineering: Compulsory Orientation Studies: Core Qualification: Elective Compulsory Orientation Studies: Core Qualification: Elective Compulsory Naval Architecture: Core Qualification: Compulsory Technomathematics: Core Qualification: Compulsory Process Engineering: Core Qualification: Compulsory Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory

Course L0882: Management Tutorial	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christoph Ihl, Katharina Roedelius
Language	DE
Cycle	WiSe/SoSe
Content	In the management tutorial, the contents of the lecture will be deepened by practical examples and the application of the discussed tools. If there is adequate demand, a problem-oriented tutorial will be offered in parallel, which students can choose alternatively. Here, students work in groups on se selected projects that focus on the elaboration of an innovative business idea from the point of view of an established company or a startup. Again, the busin knowledge from the lecture should come to practical use. The group projects are guided by a mentor.
Literature	Relevante Literatur aus der korrespondierenden Vorlesung.

Course L0880: Introduction to Management	
Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Christoph Ihl, Prof. Christian Lüthje, Prof. Christian Ringle, Prof. Cornelius Herstatt, Prof. Kathrin Fischer, Prof. Matthias Meyer, Prof. Thomas Wrona, Prof. Thorsten Blecker, Prof. Wolfgang Kersten
Language	DE
Cycle	WiSe/SoSe
Content	• Introduction to Business and Management, Business versus Economics, relevant areas in Business and Management • Important definitions from Management, • Developing Objectives for Business, and their relation to important Business functions • Business Functions: Functions of the Value Chain, e.g. Production and Procurement, Supply Chain Management, Innovation Management, Marketing and Sales Cross-sectional Functions, e.g. Organisation, Human Ressource Management, Supply Chain Management, Information Management • Definitions as information, information systems, aspects of data security and strategic information systems • Definition and Relevance of innovations, e.g. innovation opporunities, risks etc. • Relevance of marketing, B2B vs. B2C-Marketing • different techniques from the field of marketing (e.g. scenario technique), pricing strategies • important organizational structures • basics of human ressource management • Introduction to Business Planning and the steps of a planning process • Decision Analysis: Elements of decision problems and methods for solving decision problems • Selected Planning Tasks, e.g. Investment and Financial Decisions • Introduction to Accounting: Accounting, Balance-Sheets, Costing • Relevance of Controlling and selected Controlling methods • Important aspects of Entrepreneurship projects
Literature	Bamberg, G., Coenenberg, A.: Betriebswirtschaftliche Entscheidungslehre, 14. Aufl., München 2008 Eisenführ, F., Weber, M.: Rationales Entscheiden, 4. Aufl., Berlin et al. 2003 Heinhold, M.: Buchführung in Fallbeispielen, 10. Aufl., Stuttgart 2006. Kruschwitz, L.: Finanzmathematik. 3. Auflage, München 2001. Pellens, B., Fülbier, R. U., Gassen, J., Sellhorn, T.: Internationale Rechnungslegung, 7. Aufl., Stuttgart 2008. Schweitzer, M.: Planung und Steuerung, in: Bea/Friedl/Schweitzer: Allgemeine Betriebswirtschaftslehre, Bd. 2: Führung, 9. Aufl., Stuttgart 2005. Weber, J., Schäffer, U. : Einführung in das Controlling, 12. Auflage, Stuttgart 2008. Weber, J./Weißenberger, B.: Einführung in das Rechnungswesen, 7. Auflage, Stuttgart 2006.

Module M1887: Transportation Planning and Traffic Engineering

Courses

Title	Typ	Hrs/wk	CP
Transport Planning and Traffic Engineering (L0997)	Project-/problem-based Learning	4	6

Module Responsible	Prof. Carsten Gertz
Admission Requirements	None
Recommended Previous Knowledge	None
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to • understand the facts, contexts and objectives of transport planning. • correctly apply definitions and concepts of transport planning. • reproduce basic concepts of transport modelling. • explain the fundamentals of traffic engineering and transport infrastructure construction.
Skills	Students are able to • analyse transport supply based on key metrics. • estimate transport demand using key metrics. • design transport networks, links and junctions. • calculate traffic signal plans. • assess transport concepts.
Personal Competence	
Social Competence	Students are able to • get together in groups and constructively discuss and analyse set problems. • in a group agree on solutions and document them.
Autonomy	Students are able to • produce reports on group work. • structure the tasks and timing for working out a set problem.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	Compulsory: No; Bonus: 5 %; Form: Excercises; Description:
Examination	Subject theoretical and practical work
Examination duration and scale	Project report in four work packages, in small groups, during the semester
Assignment for the Following Curricula	Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory

Course L0997: Transport Planning and Traffic Engineering	
Typ	Project-/problem-based Learning
Hrs/wk	4
CP	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Carsten Gertz
Language	DE
Cycle	WiSe
Content	The course provides an introductory overview over the fundamentals of urban and regional transport planning, including the sub-topic traffic engineering. The following subject areas are covered: • objectives of transport planning, • key mobility metrics, • measuring and predicting demand, • designing and planning transport infrastructure, • fundamentals of traffic engineering and • an introduction to transport concepts and planning processes.
Literature	Bosserhoff, Dietmar (2000) Integration von Verkehrsplanung und räumlicher Planung. Schriftenreihe der Hessischen Straßen- und Verkehrsverwaltung, Heft 42. Hessisches Landesamt für Straßen- und Verkehrswesen. Wiesbaden. Lohse, Dieter; Schnabel, Werner (2011) Grundlagen der Straßenverkehrstechnik und der Verkehrsplanung: Band 1; Straßenverkehrstechnik. Beuth Verlag. Berlin. Forschungsgesellschaft für Straßen- und Verkehrswesen (2006) Richtlinien für die Anlage von Stadtstraßen - RASt 06. FGSV-Verlag. Köln (FGSV, 200). Vallée, Dirk; Engel, Barbara; Vogt, Walter (2021) Stadtverkehrsplanung Band 3, Springer Verlag. Berlin.

Module M0985: Introduction to Railways

Courses

Title	Typ	Hrs/wk	CP
Introduction to Railways (L1184)	Lecture	2	4
Introduction to Railways (L1185)	Recitation Section (large)	1	2

Module Responsible	Prof. Carsten Gertz
Admission Requirements	None
Recommended Previous Knowledge	none
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can... • give definitions for basic terms related to railways • explain specifics concerning the handling of goods on railways • explain the required infrastructure • describe the work at the track super structure
Skills	--
Personal Competence	
Social Competence	Students can... • work at tasks in groups and come to results together • discuss contents in groups, summarize them and present them in front of others • convey contents to other by processing them in writing
Autonomy	Students can work out and understand contents themselves during the lecture through literature research
Workload in Hours	Independent Study Time 138, Study Time in Lecture 42
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory

Course L1184: Introduction to Railways

Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	André Schoppe
Language	DE
Cycle	SoSe
Content	Lecture: The module provides a basic knowledge of the field of railroad engineering. An overview of railroad operations, control and safety technology, railroad superstructure, structural engineering, project management as well as maintenance and design of infrastructure facilities is given. The aim of this module is to give students as much insight as possible into railroad infrastructure. The module is examined by means of a written exam at the end of the semester. Lecture Hall Exercise: In order to give the students practical examples, full-day practical excursions are carried out. New handling techniques and currently available hardware will be presented by visiting the marshalling yard "die Zugbildungsanlage Maschen (ZBA)". Furthermore, the training center for track construction and civil engineering as well as the operations center in Hanover will be visited, where facilities and tasks will be presented. Questionnaires will also be provided for practice purposes. In addition, study papers can be handed out and supervised as required.
Literature	Die maßgebliche Literatur wird in StudIP veröffentlicht. Weitere Hinweise werden in der Veranstaltung gegeben.

Course L1185: Introduction to Railways	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	André Schoppe
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1629: Geoinformation Science

Courses

Title	Typ	Hrs/wk	CP
Introduction to Geoinformation Science (L2465)	Project-/problem-based Learning	3	3

Module Responsible	Prof. Peter Fröhle
Admission Requirements	None
Recommended Previous Knowledge	Principles of analysis and linear algebra
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are able to define the tasks and terms from the field of application of geo information systems. They can report the basics, the basic approaches and methods of geo information systems and are able to transfer these to practical questions.
Skills	Students are able to apply the basic methods used in geo-information systems to practical problems. They are able to apply them to simple applications of geographic information systems and to transfer them to other problems. The students can process a simple GIS project and present their results.
Personal Competence	
Social Competence	The students can work together groups cooperatively and productively.
Autonomy	Students are able to organize their work flow to prepare themselves before presentations and discussion. They can acquire appropriate knowledge by making enquiries independently.
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Credit points	3
Course achievement	None
Examination	Subject theoretical and practical work
Examination duration and scale	Computer aided GIS-Application and written-theoretical part
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Compulsory

Course L2465: Introduction to Geoinformation Science

Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Yohannis Tadesse
Language	DE
Cycle	SoSe
Content	• Theoretical basics of Geo-Information-Systems • Data models, geographical coordinates, geo-referencing, map-views • Data mining and -analyses of geo-data • Analysis techniques
Literature	

Module M0612: Steel Structures II

Courses

Title	Typ	Hrs/wk	CP
Steel Structures II (L0301)	Lecture	2	3
Steel Structures II (L0302)	Recitation Section (large)	2	3

Module Responsible	Prof. Marcus Rutner
Admission Requirements	None
Recommended Previous Knowledge	Steel Structures I
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After successful completition students can • describe and explain the behaviour of bolted and welded connections • design and check simple halls and buildings • calculate forces and stresses of simple structures (trusses, beams, frames) • illustrate and dimension he main details (framework, column base, load application points)
Skills	Students are able to design simple structures and connections, describe the load distribution and recognize the possible modes of failure. They can apply structural imperfections, calculate according to 2nd order theory and verify their results.
Personal Competence	
Social Competence	--
Autonomy	--
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	120 minutes
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory

Course L0301: Steel Structures II

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	SoSe

Content	• Welded connections
	• Simple constructions
	  ◦ Trusses
	  ◦ Plate girders
	  ◦ Frames
	  ◦ Columns
	• Buildings with several storeys
	• Halls

Literature	Petersen, C.: Stahlbau, 4. Auflage 2013, Springer-Vieweg Verlag Wagenknecht, G.: Stahlbau-Praxis nach Eurocode 3, Bauwerk-Verlag 2011 • Band 1 Tragwerksplanung, Grundlagen • Band 2 Verbindungen und Konstruktionen

Course L0302: Steel Structures II

Typ	Recitation Section (large)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1630: Sanitary Engineering II

Courses

Title	Typ	Hrs/wk	CP
Management of Wastewater Infrastructure (L2467)	Seminar	2	3
Drinking Water Treatment (L2466)	Seminar	2	3

Module Responsible	Prof. Mathias Ernst
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge in the field of drinking water supply and waste water disposal.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can examplify their expert knowledge on drinking water, waste water treatment and the associated infrastructure systems. They are capable of reproducing the relevant empiricals assumptions and scientific simplifcations in detail. The students can model some processes mathematically. They can also assess existing problems in the field of sanitary engineering, such as removal of nitrate, and place them in a socio-political context. Furthermore, they know how to draft the features and effectiveness of important technologies of the future such as high- and low-pressure membrane filtration systems and techniques.
Skills	The students are able to apply the relevant standards and guidelines for the design and operation of urban water infrastructures independently. Their expertise comprises expert skills to design drinking water supply and urban drainage systems as well as the associated treatment facilities. Besides the acquirement of technical skills the students are able to address and solve biochemical problems in the filed of drinking water and wastewater treatment. The students are also able to develop ideas of their own to improve the existing water related infrastructures, systems and concepts.
Personal Competence	
Social Competence	The students are able to develop a specific topic in a team and to work out milestones according to a given plan.
Autonomy	Students are in a position to work on a subject and to organize their work flow independently. They can also present on this subject.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Subject theoretical and practical work
Examination duration and scale	Written-theoretical part and modelling
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Water and Environmental Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Water Technologies: Elective Compulsory

Course L2467: Management of Wastewater Infrastructure

Typ	Seminar
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	DE
Cycle	SoSe
Content	The seminar ""Infrastructure Management Wastewater"" develops the understanding of infrastructure systems in relation to wastewater systems, but also addresses other infrastructure systems. Initially, an overview of the entire system is given, including water catchment areas, water distribution, the origin of wastewater in households and industry, stormwater runoff management, and the treatment and reuse of water (constituents). Thereby the design tools especially of digital modelling are understood by practical application. Energetic considerations as well as planning and restoration of pipeline systems are covered. For wastewater treatment, the basis developed in Sanitary Engineering I will be deepened and significantly expanded, especially the resource recovery of nutrients and water. Sanitary solutions for different socio-economic and climatic conditions are understood and calculated.
Literature	Gujer, W. (2007): Siedlungswasserwirtschaft, Springer, Berlin Heidelberg Metcalf and Eddy (2003): Wastewater Engineering : Treatment and Reuse, Boston, McGraw-Hill Henze, M. (1997): Wastewater Treatment : Biological and Chemical Processes, Berlin, Springer Stein D., Stein R. (2014): Instandhaltung von Kanalisationen, Verlag Prof. Dr.-Ing. Stein & Partner GmbH Wossog, G. (2016): Handbuch für den Rohrleitungsbau Band 1 und 2 Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (2009): Abwasserableitung : Bemessungsgrundlagen, Regenwasserbewirtschaftung, Fremdwasser, Netzsanierung, Grundstücksentwässerung, Weimar, Univ.-Verl. DWA Arbeitsblätter

Course L2466: Drinking Water Treatment	
Typ	Seminar
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Mathias Ernst, Dr. Klaus Johannsen
Language	DE
Cycle	SoSe
Content	The seminar deepens and expands the knowledge of the processes of drinking water treatment. The seminar deals with ion exchange, oxidation, disinfection, gas exchange and hybrid treatment processes. Further topics include pH adjustment and energy efficiency in water supply. Within the scope of the course, the students work out a seminar performance (presentation, design, modelling) on the basis of a task.
Literature	Worch, E. (2019): Drinking Water Treatment, De Gruyter-Verlag Worch, E. (2015): Hydrochemistry, De Gruyter-Verlag Jekel, M., Czekalla, C. (2016): Wasseraufbereitung - Grundlagen und Verfahren (DVGW Lehr- und Handbuch Wasserversorgung, Band 6), DIV Deutscher Industrieverlag

Module M1633: Planning Law and Environmental Law/ Sustainable Urban Development

Courses

Title	Typ	Hrs/wk	CP
Sustainable Urban Development (L2474)	Lecture	2	3
Planning law and Environmental law (L2473)	Lecture	2	3

Module Responsible	Prof. Ralf Otterpohl
Admission Requirements	None
Recommended Previous Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence *Knowledge* *Skills* **Personal Competence** *Social Competence* *Autonomy*	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Subject theoretical and practical work
Examination duration and scale	Written-theoretical part and report
Assignment for the Following Curricula	Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory

Course L2474: Sustainable Urban Development

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Irene Peters
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2473: Planning law and Environmental law

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Martin Wickel
Language	DE
Cycle	SoSe
Content	
Literature	

Module M1632: Applied Water Management

Courses

Title	Typ	Hrs/wk	CP
Nature-oriented Hydraulic Engineering (L2472)	Project-/problem-based Learning	2	2
Numerical modelling of soil water dynamics (L2471)	Project-/problem-based Learning	2	2
Numerical modelling of soil water dynamics (L2470)	Lecture	2	2

Module Responsible	Prof. Peter Fröhle
Admission Requirements	None
Recommended Previous Knowledge	• Basic knowledge of analysis and differential equations • hydromechanical and hydraulic engineering principles
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to define the basic tasks and terms of nature-oriented hydraulic engineering und groundwater hydrology. They cam describe the basics concepts, the basic approaches and methods of nature-oriented hydraulic engineering, groundwater hydrology and groundwater modelling and are able to apply these to practical problems.
Skills	The students are able to apply the methods and approaches of nature-oriented hydraulic engineering and of groundwater hydrology to practical problems. They can demonstrate to transfer and apply these to simple hydraulic engineering systems. In addition, they are able to apply the approaches commonly used in groundwater hydrology. They can exemplarily explain and reason how to apply them as a basis for geo-hydrological questions. In addition, students can apply basic groundwater modelling methods to simple problems of groundwater movement and groundwater recharge.
Personal Competence	
Social Competence	Students are able to help each other solving case studies. The students are able to deploy their gained knowledge in applied problems of the practical nature-based hydraulic engineering. Additionaly, they will be able to demonstrate to work cooperatively in teams consisting of engineers from different subject areas.
Autonomy	The students will be able to independently extend their knowledge and apply it to new problems.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Subject theoretical and practical work
Examination duration and scale	Written-theoretical part and modeling
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Water and Environmental Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Water Technologies: Elective Compulsory

Course L2472: Nature-oriented Hydraulic Engineering

Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	SoSe
Content	• Regime-theory and application for the development of environmental guiding priciples of rivers • Engineering-biological measures for the stabilization of rivers • design techniques for water engineering • hydraulic dimensioning of river bed and bank protection • design principles and design techniques for fish passages (fish ladder, ramps etc.)
Literature	

Course L2471: Numerical modelling of soil water dynamics

Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Hannes Nevermann
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L2470: Numerical modelling of soil water dynamics	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Milad Aminzadeh
Language	EN
Cycle	SoSe
Content	• Hydrologic water bilance • aquifertyps • groundwater velocities • Darcy law • groundwater contour lines • storage capacity • flow equation • pumping tests • method of Beyer • solute transport in groundwater • Basics and theoretical background of simulation methods for the analysis of water movement in vadose zone • groundwater recharge
Literature	Todd, K. (2005): Groundwater Hydrology Fetter, C. W. (2001): Applied Hydrogeology Hölting, B. & Coldewey, W. (2005): Hydrogeologie Charbeneau, R. J. (2000): Groundwater Hydraulics and pollutant Transport

Module M1723: Building Information Modeling

Courses

Title	Typ	Hrs/wk	CP
Building Information Modeling (L2760)	Integrated Lecture	2	2
Building Information Modeling (L2761)	Recitation Section (small)	2	4

Module Responsible	Prof. Kay Smarsly
Admission Requirements	None
Recommended Previous Knowledge	None
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The contents of this module follow the recommendations of the German Association of Computing in Civil Engineering (www.gacce.de) for the BIM courses taught at German universities in the subject area of engineering informatics. The module aims to present methodological knowledge to enable students to introduce, to design, to monitor, and to improve BIM processes in companies and public institutions. An in-depth understanding of the methods and technologies relevant to BIM is essential. Emphasis is placed on generally valid principles and techniques independent of specific software products and valid for several decades. The theoretical content taught in the lecture is complemented by practical exercises, in which state-of-the-art software tools will be used. Topics include computer-aided design and geometry modeling, digital modeling of buildings and infrastructure, BIM data exchange and cooperation (focusing on Industry Foundation Classes), process modeling, job descriptions and BIM applications, BIM tools, and advanced aspects. A central component of this module will be a project work.
Skills	
Personal Competence	
Social Competence	
Autonomy	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and scale	Description of a BIM model with 15-minute oral presentation
Assignment for the Following Curricula	Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory

Course L2760: Building Information Modeling

Typ	Integrated Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kay Smarsly
Language	DE
Cycle	SoSe
Content	• Historical development • Introduction and motivation • Basics of geometry • 2D geometry modeling • 2½D geometry modeling • 3D geometry modeling • Digital modeling of buildings and infrastructure, object-oriented, semantic, and parametric modeling • Data exchange, interoperability, and communication (with emphasis on Industry Foundation Classes) • BIM data storage and data management • Process modeling • Job profiles and applications • BIM tools • Advanced aspects of BIM • Seminar by external BIM experts and project presentations
Literature	

Course L2761: Building Information Modeling

Typ	Recitation Section (small)
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Kay Smarsly
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Specialization Water and Environment

Module M1628: Sustainable Building

Courses

Title	Typ	Hrs/wk	CP
Circular flow economy and structural recycling (L2464)	Integrated Lecture	2	2
Sustainable building materials and buildings (L3179)	Integrated Lecture	2	2
Sustainable water management and hydraulic engineering (L3180)	Integrated Lecture	2	2

Module Responsible	Prof. Peter Fröhle
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge of building materials, building chemistry, building construction and building project management
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to reproduce essential features of sustainable construction and material cycles. They can also name the constructional and environmental properties of recyclates and describe the sampling and analysis process. They are able to give an overview of the history, definition and to provide strategic approaches to the sustainability discussion from a constructional and environmental perspective. Furthermore, they can explain relevant objectives, strategies and exemplary fields of research in the field of sustainable construction (e.g. environmental impacts of the production and use of building materials, life cycle assessment, energy and climate-optimised planning and construction, material principles of renewable raw materials). Students will be able to discuss the fundamental relationship between the origin and type of construction waste, quantities produced and methods for characterising them.
Skills	Students can relate relevant legal requirements to practical problems of environmentally sound design and construction and thus justify the application of specific limit values for individual areas of application. Students are able to assess risks that may arise from hazardous construction waste in a concise manner. They are able to critically examine innovative areas of application of sustainable construction on the basis of central engineering, economic and legal criteria. They can thereafter evaluate and propose approaches for alternative solutions exemplarily, e.g. for the processing and recycling of construction waste.
Personal Competence	
Social Competence	The students are able to work out their own solutions for specific problems of recycling building materials in small groups. For this purpose, they can organise themselves in a division of labour and can give themselves a work and project plan. Furthermore, they are able to appoint group members to coordinate the cooperation with other working groups of the module and to moderate the presentation of work results in the seminar.
Autonomy	Students can coordinate their individual work performance with the other members of the group and prepare for it efficiently by use of scientific media.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	Compulsory: Yes; Bonus: 20 %; Form: Written elaboration; Description:
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	Civil- and Environmental Engineering: Specialisation Water and Environment: Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Integrated Building Technology: Core Qualification: Compulsory

Course L2464: Circular flow economy and structural recycling

Typ	Integrated Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kerstin Kuchta
Language	DE
Cycle	SoSe
Content	• Types, origin, quantities of construction waste and building debris • Risks and characterisation of construction waste • Avoidance strategies and recycling options for construction waste and building debris • Criteria of sampling, analysis and opportunities for the use of treated building materials • political and legal requirements for the recycling of building materials
Literature	Friedrichsen, S. (2018). Nachhaltiges Planen, Bauen und Wohnen: Kriterien für Neubau und Bauen im Bestand. 2. Aufl. Berlin, Springer Müller et al. (2017). Nachhaltiges Bauen des Bundes: Grundlagen, Methoden, Werkzeuge (Schriftenreihe Zukunft Bauen, Band 08)

Course L3179: Sustainable building materials and buildings	
Typ	Integrated Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Sebastian Rybczynski
Language	DE
Cycle	SoSe
Content	
Literature	

Course L3180: Sustainable water management and hydraulic engineering	
Typ	Integrated Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	SoSe
Content	
Literature	

Module M0755: Geotechnics II

Courses

Title	Typ	Hrs/wk	CP
Foundation Engineering (L0552)	Lecture	2	2
Foundation Engineering (L0553)	Recitation Section (large)	2	2
Foundation Engineering (L1494)	Recitation Section (small)	2	2

Module Responsible	Prof. Jürgen Grabe
Admission Requirements	None
Recommended Previous Knowledge	Modules: • Mechanics I-II • Geotechnics I
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students know the basic principles and methods which are required to verificate the stability of geotechnical structures.
Skills	After successful completion of the module the students are able to: • verificate the stability and usability of foundations, • know individual methods of ground improvement and apply them in their range of application, • design retaining walls.
Personal Competence	
Social Competence	
Autonomy	
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	Compulsory: No; Bonus: 20 %; Form: Attestation; Description:
Examination	Written exam
Examination duration and scale	90 minutes
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0552: Foundation Engineering

Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	• Shallow foundations • Pile foundations • Ground improvement • Retaining walls • Underpinning • Groundwater Conservation • Cut-off Walls
Literature	• Vorlesung/Übung s. www.tu-harburg.de/gbt • Grabe, J. (2004): Bodenmechanik und Grundbau • Kolymbas, D. (1998): Geotechnik - Bodenmechanik und Grundbau • Grundbau-Taschenbuch, neueste Auflage

Course L0553: Foundation Engineering

Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1494: Foundation Engineering	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Jürgen Grabe
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0983: Mobility Concepts

Courses

Title	Typ	Hrs/wk	CP
Mobility Research and Transportation Projects (L1181)	Project-/problem-based Learning	3	3
Mobility in Megacities and Developing Countries (L1182)	Seminar	3	3

Module Responsible	Dr. Philine Gaffron
Admission Requirements	None
Recommended Previous Knowledge	Module Transportation Planning and Traffic Engineering
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to: • name the different urban transport systems existing around the world. • explain the transport challenges in Asian and African mega cities. • recognise and relate interactions between transport systems on the one hand and ecological, socio-cultural and economic problem areas on the other. • outline specific issues and problems in urban development and transport (in Germany and developing countries). • explain the effects of external framework factors (like energy costs) on transport.
Skills	Students are able to: • analyse and evaluate given case studies. • transfer learning results to other regions and cities. • analyse specific issues and problems in urban development and transport (in developing countries). • critically assess actors, planning objectives, planned measures and the implementation of transport projects in the light of the UN Millennium Development Goals • develop and present sustainable (i.e. ecological, poverty oriented, gender balanced and economical) solutions for urban personal and goods transport
Personal Competence	
Social Competence	Students are able to: • present and explain independently generated findings. • constructively discuss potentially controversial topics in a group context.
Autonomy	Students are able to: • carry out independent literature research and analysis. • independently author a written report on a given topic.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	Compulsory: Yes; Bonus: None; Form: Participation in excursions; Description: Exkursion innerhalb Hamburgs abhängig von aktuellen Themen im Modul
Examination	Written elaboration
Examination duration and scale	All assignments in groups (2-4 students): written report, 2000 words (incl. 2 short presentations of 10 mins.); final presentation, 20 mins. plus discussion (incl. slides) and 1000 word report incl. peer review (individual).
Assignment for the Following Curricula	Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Logistics and Mobility: Specialisation Traffic Planning and Systems: Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Compulsory

Course L1181: Mobility Research and Transportation Projects	
Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Dr. Philine Gaffron
Language	DE
Cycle	SoSe
Content	This course places its focus on transport and mobility in Germany. It deals with questions such as: • Which external factors - like e.g. energy costs, availability of renewable and fossil fuels, environmental and climate protection objectives - influence current developments in the transport sector? • Which external effects in turn are caused by mobility choices and traffic? • How should these interactions be evaluated, how and by whom can they be influenced? • Which measures at the municipal level can contribute to a more sustainable transport system? During the course, these questions will be illustrated and discussed with reference to different examples and current developments. Participants will also provide input on specific topics. Potential core subjects of the course could be: • Environmental Justice : which population groups are disproportionately affected by transport emissions and who causes them? • Municipal cycle planning • Transport and Climate Protection: can, want, act - everything could be, nothing must be?
Literature	Die Literaturempfehlungen sind abhängig von den jeweiligen, wechselnden Themenschwerpunkten und werden rechtzeitig vor Beginn der Veranstaltung bekannt gegeben.

Course L1182: Mobility in Megacities and Developing Countries	
Typ	Seminar
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Dr. Jürgen Perschon, Christof Hertel
Language	DE
Cycle	SoSe
Content	The course provides and overview over different transport projects in the metropolitan areas of developing countries. Considering different perspectives on urban growth, social justice, economic development, environmental and climate protection as well as the economic viability of public transport, the specific situation in the urban conglomerates of Asia, Latin America and Africa will be analysed and placed in a regional and global context. Specific public transport systems will be examined to establish, whether they are a suitable example for sustainable urban development. The following examples could be suitable case studies: Singapore (Metro), Lagos (BRT Light), Guanghzou, Bogota, Jakarta (Full BRT), Sao Paulo, Medellin (Cable Car Systems), Johannesburg (Minibus-Taxi). The course will be designed interactively with the students and will partly be in English as is the majority of the literature in this area (also: Skype online interviews with international experts in the transport sector). **An English language presentation is also part of the course work.**
Literature	--

Module M1715: Renewable Energies

Courses

Title	Typ	Hrs/wk	CP
Fuels II (L3143)	Lecture	1	1
Renewable Energies I (L2740)	Lecture	2	2
Renewable Energies I (L2742)	Recitation Section (large)	1	1
Renewable Energies II (L2741)	Lecture	2	2

Module Responsible	Prof. Martin Kaltschmitt
Admission Requirements	None
Recommended Previous Knowledge	none
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Upon completion of this module, students will be able to provide an overview of characteristics of renewable energy systems. They will be able to explain the issues that arise in these systems. Furthermore, they are able to explain knowledge of energy supply, energy distribution and energy trading in this context, taking into account contexts bordering on specific disciplines. The students can explain this knowledge in detail for such energy systems and take a critical stand on it. Furthermore, they can explain the environmental impact of using renewable energy systems and have an overview of the economic classification of the respective options.
Skills	Students are able to apply methodologies for determining energy demand or energy supply to different types of renewable energy systems. Furthermore, they can evaluate such energy systems technically, ecologically and economically as well as systemically and also design them under certain given conditions. They are able to select the regulations necessary for this in a subject-specific manner, especially by means of non-standard solutions to a problem. Students are able to orally explain issues from the subject area and approaches to dealing with them and to classify them in the respective context.
Personal Competence	
Social Competence	Students are able to investigate suitable technical alternatives and ultimately evaluate them based on technical, economic and ecological criteria - and thus from a sustainability perspective.
Autonomy	Students will be able to independently access sources about the field, acquire knowledge and transform it to address new issues.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	150 min
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Green Technologies: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Engineering: Compulsory Green Technologies: Energy, Water, Climate: Core Qualification: Compulsory Process Engineering: Core Qualification: Compulsory

Course L3143: Fuels II	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Karsten Wilbrand
Language	DE
Cycle	SoSe
Content	• Regulatory requirements of "alternative" fuels (e.g. RED) • Overview of today's alternative fuels o Biodiesel / HEFA o Bioethanol o Biomethane o Other fuels • Overview of future alternative fuels o 2nd generation biofuels o Hydrogen and hydrogen derivatives o Electricity-based fuels o Other fuels • Electromobility o with battery o with hydrogen fuel cell • Markets and market developments • CO2 analyses of the various options per application area • Global megatrends and future challenges • Developments in vehicle and drive technologies • Energy scenarios up to 2050 and significance for the mobility sector
Literature	Eigene Unterlagen, Veröffentlichungen, Fachliteratur Literature: Own documents, publications, technical literature

Course L2740: Renewable Energies I	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe
Content	This module includes a presentation of the renewable energy supply and a discussion of the respective technologies for providing the desired final or useful energy. Specifically, this includes the options for solar energy use for heat and power generation (i.e., passive solar energy use, solar collectors for low-temperature heat provision, solar thermal power generation, photovoltaic power generation), wind energy use for power generation (i.e. onshore and offshore wind power use), hydroelectric power use for electricity generation (i.e., run-of-river and storage hydroelectric power), ocean energy use for electricity generation (including tidal power plants), and geothermal energy use for heat and electricity generation (i.e., near-surface use by means of heat pumps, deep geothermal energy use for heat and/or electricity generation).
Literature	Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Erneuerbare Energien - Systemtechnik, Wirtschaftlichkeit, Umweltaspekte; Springer, Berlin, Heidelberg, 2020, 6. Auflage

Course L2742: Renewable Energies I	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe
Content	Students work on different tasks in the field of renewable energies. They present their solutions in the exercise lesson and discuss it with other students and the lecturer. Possible tasks in the field of renewable energies are: • Solar thermal heat • Concentrating solare power • Photovoltaic • Windenergie • Hydropower • Heat pump Deep geothermal energy
Literature	Kaltschmitt, M.; Streicher, W.; Wiese, A. (Hrsg.): Erneuerbare Energien - Systemtechnik, Wirtschaftlichkeit, Umweltaspekte; Springer, Berlin, Heidelberg, 2020, 6. Auflage

Course L2741: Renewable Energies II	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Martin Kaltschmitt
Language	DE
Cycle	SoSe
Content	This lecture covers all options for energy supply from biomass; this includes the supply of heat, electricity and fuels. The biomass resource and its origin will be discussed first. Afterwards the biomass supply is addressed, which bridges the gap between biomass generation and utilization. Subsequently, the different conversion options are discussed. Only those options are presented in depth that have a corresponding significance on the market in Germany and Europe. This includes (a) heat generation from biogenic solid fuels in small and large-scale plants (b) power generation from solid biomass via combustion (c) a biogas production from residues, by-products and waste, (d) alcohol production from sugar and starch (e) biodiesel production from vegetable oils. Special attention is also paid to the corresponding environmental aspects. An economic classification of the various options is also provided.
Literature	Unterlagen der Vorlesung

Module M0631: Reinforced Concrete Structures II

Courses

Title	Typ	Hrs/wk	CP
Project Concrete Structures II (L0894)	Project Seminar	1	1
Concrete Structures II (L0348)	Lecture	2	3
Concrete Structures II (L0349)	Recitation Section (large)	2	2

Module Responsible	Prof. Günter Rombach
Admission Requirements	None
Recommended Previous Knowledge	• Knowledge of loads on structures and combination of actions • Basics of safety format are required. • Knowledge in design of beams and columns for ultimate limit state • Modules: Reinforced Concrete Structures I, Structural Analysis I+II, Mechanics I+II
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students know the basic principles which are required for design of reinforced concrete structures. They know the various methods to estimate the member forces in simple one and two-way slabs.
Skills	• The students can design reinforced concrete structure in the ultimate limit state (shear, bending, torsion) and in the serviceability limit state (crack and deflection control) including detailing (anchorage and links etc.). • The students can estimate the member forces of simple slabs. • The students know the content and the layout of a structural analysis
Personal Competence	
Social Competence	Cooperation in a project work, where they design in a team a real concrete building and present the results at the end.
Autonomy	Students are able to design simple reinforced concrete structures and evaluate the results.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	**Compulsory** / **Bonus** / **Form** / **Description**: No / None / Excercises
Examination	Written exam
Examination duration and scale	120 minutes
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory

Course L0894: Project Concrete Structures II

Typ	Project Seminar
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Günter Rombach
Language	DE
Cycle	WiSe
Content	Design of a truss structure
Literature	Skript zur Lehrveranstaltung "Stahlbetonbau II"

Course L0348: Concrete Structures II	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Günter Rombach
Language	DE
Cycle	WiSe
Content	• Design of concrete members for shear, punching and torsion • Design for serviceability limit state (durability): crack- and deflection control • Detailing • Design of discontinuity regions (e.g. corbels, frame corner) • design of footings • Introduction in the design of slabs • Layout and content of a structural design
Literature	• Vorlesungsumdrucke zum downloaden im STUDiP • Zilch K., Zehetmaier G.: Bemessung im konstruktiven Betonbau. Springer Verlag, 2010 • König G., Tue N.: Grundlagen des Stahlbetonbaus. Teubner Verlag, Stuttgart 1998 • Deutscher Beton- und Bautechnikverein E.V.: Beispiele zur Bemessung von Betontragwerken nach Eurocode 2. Band 1: Hochbau, Bauverlag GmbH, Wiesbaden 2011 • Dahms K.-H.: Rohbauzeichnungen, Bewehrungszeichnungen. Bauverlag, Wiesbaden 1997 • Grasser E. ,Thielen G.: Hilfsmittel zur Berechnung der Schnittgrößen und Formänderungen von Stahlbetontragwerken. Deutscher Ausschuss für Stahlbeton, Heft 240, Verlag Ernst & Sohn, Berlin 1978 • DIN EN 1992-1-1:2011: Bemessung und Konstruktion von Stahlbeton- und Spannbetontragwerken - Teil 1: Allgemeine Bemessungsregeln für den Hochbau.

Course L0349: Concrete Structures II	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Günter Rombach
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0829: Foundations of Management

Courses

Title	Typ	Hrs/wk	CP
Management Tutorial (L0882)	Recitation Section (small)	2	3
Introduction to Management (L0880)	Lecture	3	3

Module Responsible	Prof. Christoph Ihl
Admission Requirements	None
Recommended Previous Knowledge	Basic Knowledge of Mathematics and Business
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After taking this module, students know the important basics of many different areas in Business and Management, from Planning and Organisation to Marketing and Innovation, and also to Investment and Controlling. In particular they are able to • explain the differences between Economics and Management and the sub-disciplines in Management and to name important definitions from the field of Management • explain the most important aspects of and goals in Management and name the most important aspects of entreprneurial projects • describe and explain basic business functions as production, procurement and sourcing, supply chain management, organization and human ressource management, information management, innovation management and marketing • explain the relevance of planning and decision making in Business, esp. in situations under multiple objectives and uncertainty, and explain some basic methods from mathematical Finance • state basics from accounting and costing and selected controlling methods.
Skills	Students are able to analyse business units with respect to different criteria (organization, objectives, strategies etc.) and to carry out an Entrepreneurship project in a team. In particular, they are able to • analyse Management goals and structure them appropriately • analyse organisational and staff structures of companies • apply methods for decision making under multiple objectives, under uncertainty and under risk • analyse production and procurement systems and Business information systems • analyse and apply basic methods of marketing • select and apply basic methods from mathematical finance to predefined problems • apply basic methods from accounting, costing and controlling to predefined problems
Personal Competence	
Social Competence	Students are able to • work successfully in a team of students • to apply their knowledge from the lecture to an entrepreneurship project and write a coherent report on the project • to communicate appropriately and • to cooperate respectfully with their fellow students.
Autonomy	Students are able to • work in a team and to organize the team themselves • to write a report on their project.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Subject theoretical and practical work
Examination duration and scale	several written exams during the semester
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Core Qualification: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Bioprocess Engineering: Core Qualification: Compulsory Chemical and Bioprocess Engineering: Specialisation Bio Engineering: Elective Compulsory Chemical and Bioprocess Engineering: Specialisation Chemical Engineering: Elective Compulsory Computer Science: Core Qualification: Compulsory Data Science: Core Qualification: Compulsory Electrical Engineering: Core Qualification: Compulsory Green Technologies: Energy, Water, Climate: Specialisation Biotechnologies: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Systems / Renewable Energies: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Energy Technology: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Maritime Technologies: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Water Technologies: Elective Compulsory Computer Science in Engineering: Core Qualification: Compulsory Integrated Building Technology: Core Qualification: Compulsory Logistics and Mobility: Core Qualification: Compulsory Mechanical Engineering: Core Qualification: Compulsory Mechatronics: Specialisation Naval Engineering: Compulsory

	Mechatronics: Specialisation Electrical Systems: Compulsory Mechatronics: Specialisation Dynamic Systems and AI: Compulsory Mechatronics: Core Qualification: Compulsory Mechatronics: Specialisation Robot- and Machine-Systems: Compulsory Mechatronics: Specialisation Medical Engineering: Compulsory Orientation Studies: Core Qualification: Elective Compulsory Orientation Studies: Core Qualification: Elective Compulsory Naval Architecture: Core Qualification: Compulsory Technomathematics: Core Qualification: Compulsory Process Engineering: Core Qualification: Compulsory Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory

Course L0882: Management Tutorial	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christoph Ihl, Katharina Roedelius
Language	DE
Cycle	WiSe/SoSe
Content	In the management tutorial, the contents of the lecture will be deepened by practical examples and the application of the discussed tools. If there is adequate demand, a problem-oriented tutorial will be offered in parallel, which students can choose alternatively. Here, students work in groups on se selected projects that focus on the elaboration of an innovative business idea from the point of view of an established company or a startup. Again, the busin knowledge from the lecture should come to practical use. The group projects are guided by a mentor.
Literature	Relevante Literatur aus der korrespondierenden Vorlesung.

Course L0880: Introduction to Management	
Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Christoph Ihl, Prof. Christian Lüthje, Prof. Christian Ringle, Prof. Cornelius Herstatt, Prof. Kathrin Fischer, Prof. Matthias Meyer, Prof. Thomas Wrona, Prof. Thorsten Blecker, Prof. Wolfgang Kersten
Language	DE
Cycle	WiSe/SoSe
Content	• Introduction to Business and Management, Business versus Economics, relevant areas in Business and Management • Important definitions from Management, • Developing Objectives for Business, and their relation to important Business functions • Business Functions: Functions of the Value Chain, e.g. Production and Procurement, Supply Chain Management, Innovation Management, Marketing and Sales Cross-sectional Functions, e.g. Organisation, Human Ressource Management, Supply Chain Management, Information Management • Definitions as information, information systems, aspects of data security and strategic information systems • Definition and Relevance of innovations, e.g. innovation opporunities, risks etc. • Relevance of marketing, B2B vs. B2C-Marketing • different techniques from the field of marketing (e.g. scenario technique), pricing strategies • important organizational structures • basics of human ressource management • Introduction to Business Planning and the steps of a planning process • Decision Analysis: Elements of decision problems and methods for solving decision problems • Selected Planning Tasks, e.g. Investment and Financial Decisions • Introduction to Accounting: Accounting, Balance-Sheets, Costing • Relevance of Controlling and selected Controlling methods • Important aspects of Entrepreneurship projects
Literature	Bamberg, G., Coenenberg, A.: Betriebswirtschaftliche Entscheidungslehre, 14. Aufl., München 2008 Eisenführ, F., Weber, M.: Rationales Entscheiden, 4. Aufl., Berlin et al. 2003 Heinhold, M.: Buchführung in Fallbeispielen, 10. Aufl., Stuttgart 2006. Kruschwitz, L.: Finanzmathematik. 3. Auflage, München 2001. Pellens, B., Fülbier, R. U., Gassen, J., Sellhorn, T.: Internationale Rechnungslegung, 7. Aufl., Stuttgart 2008. Schweitzer, M.: Planung und Steuerung, in: Bea/Friedl/Schweitzer: Allgemeine Betriebswirtschaftslehre, Bd. 2: Führung, 9. Aufl., Stuttgart 2005. Weber, J., Schäffer, U. : Einführung in das Controlling, 12. Auflage, Stuttgart 2008. Weber, J./Weißenberger, B.: Einführung in das Rechnungswesen, 7. Auflage, Stuttgart 2006.

Module M1722: New Trends in Water and Environmental Research

Courses

Title	Typ	Hrs/wk	CP
Introduction to Microplastics in Environment (L2755)	Integrated Lecture	2	2
Research Methods (L2756)	Lecture	1	2
Research Trends (L2757)	Seminar	2	2

Module Responsible	Prof. Nima Shokri
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge in water and environmental-related research
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students will be introduced to current research topics relevant to water and environment with a particular focus on the effects of microplastics in environment (introductory level). Data analysis, curation and presentation will be other skills discussed in this module.
Skills	Students' research and academics skills will be improved in this module. How to prepare and deliver an effective research presentation, how to write an abstract, research paper and proposal will be explained in this module.
Personal Competence	
Social Competence	Developing teamwork and problem solving skills through Research-Based Teaching approaches will be at the core of this module.
Autonomy	The students will be involved in writing individual project reports and giving research presentation. This will contribute to the students' ability and willingness to work independently and responsibly.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Course achievement	None
Examination	Subject theoretical and practical work
Examination duration and scale	Report and Presentation
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Water and Environmental Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Water Technologies: Elective Compulsory

Course L2755: Introduction to Microplastics in Environment

Typ	Integrated Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Nima Shokri
Language	EN
Cycle	WiSe
Content	Introduction - course objectives, expectations and format; Source of microplastics in environment; Microplastics sampling; Characterization of microplastics; Fate and distribution of microplastics in terrestrial environments; Effects of microplastics on terrestrial environments; Health risks of microplastics in environments
Literature	1- Characterization and Analysis of Microplastics, Volume 75 1st Edition Series Volume Editors: Teresa Rocha-Santos Armando Duarte Elsevier, published in 2017 2- Microplastic Pollutants 1st Edition Authors: Christopher Blair Crawford, Brian Quinn Elsevier Science, published in 2016 3- Microplastics in Terrestrial Environments Authors: Defu He and Yongming Luo Springer, published in 2020, DOI https://doi.org/10.1007/978-3-030-56271-7

Course L2756: Research Methods	
Typ	Lecture
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Nima Shokri
Language	EN
Cycle	WiSe
Content	Introduction - course objectives, expectations and format Analyzing the Audience, purpose and occasion Constructing and delivering effective technical presentations How to write an abstract How to create a scientific poster How to write a scientific paper Individual project on water and environmental research Presentation on water and environmental research
Literature	• The Craft of Scientific Writing Fourth edition Author: Michael Alley Springer-Verlag New York, Copyright 2018, DOI 10.1007/978-1-4419-8288-9 • Supplemental materials and web links which will be available to registered students.

Course L2757: Research Trends	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Salome Shokri-Kuehni
Language	EN
Cycle	WiSe
Content	Introduction - course objectives, expectations and format Analyzing the Audience, purpose and occasion Constructing and delivering effective technical presentations How to write an abstract How to write a scientific paper Developing competitive and persuasive research proposals Databases and resources available for water and environmental research Individual proposal on water and environmental research Individual project on water and environmental research Group projects and presentation on water and environmental research
Literature	• The Craft of Scientific Writing Fourth edition Author: Michael Alley Springer-Verlag New York, Copyright 2018, DOI 10.1007/978-1-4419-8288-9 • Supplemental materials and web links which will be available to registered students.

Module M1887: Transportation Planning and Traffic Engineering

Courses

Title	Typ	Hrs/wk	CP
Transport Planning and Traffic Engineering (L0997)	Project-/problem-based Learning	4	6

Module Responsible	Prof. Carsten Gertz
Admission Requirements	None
Recommended Previous Knowledge	None
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to • understand the facts, contexts and objectives of transport planning. • correctly apply definitions and concepts of transport planning. • reproduce basic concepts of transport modelling. • explain the fundamentals of traffic engineering and transport infrastructure construction.
Skills	Students are able to • analyse transport supply based on key metrics. • estimate transport demand using key metrics. • design transport networks, links and junctions. • calculate traffic signal plans. • assess transport concepts.
Personal Competence	
Social Competence	Students are able to • get together in groups and constructively discuss and analyse set problems. • in a group agree on solutions and document them.
Autonomy	Students are able to • produce reports on group work. • structure the tasks and timing for working out a set problem.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	Compulsory: No; Bonus: 5 %; Form: Excercises; Description:
Examination	Subject theoretical and practical work
Examination duration and scale	Project report in four work packages, in small groups, during the semester
Assignment for the Following Curricula	Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Engineering and Management - Major in Logistics and Mobility: Core Qualification: Compulsory

Course L0997: Transport Planning and Traffic Engineering	
Typ	Project-/problem-based Learning
Hrs/wk	4
CP	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Carsten Gertz
Language	DE
Cycle	WiSe
Content	The course provides an introductory overview over the fundamentals of urban and regional transport planning, including the sub-topic traffic engineering. The following subject areas are covered: • objectives of transport planning, • key mobility metrics, • measuring and predicting demand, • designing and planning transport infrastructure, • fundamentals of traffic engineering and • an introduction to transport concepts and planning processes.
Literature	Bosserhoff, Dietmar (2000) Integration von Verkehrsplanung und räumlicher Planung. Schriftenreihe der Hessischen Straßen- und Verkehrsverwaltung, Heft 42. Hessisches Landesamt für Straßen- und Verkehrswesen. Wiesbaden. Lohse, Dieter; Schnabel, Werner (2011) Grundlagen der Straßenverkehrstechnik und der Verkehrsplanung: Band 1; Straßenverkehrstechnik. Beuth Verlag. Berlin. Forschungsgesellschaft für Straßen- und Verkehrswesen (2006) Richtlinien für die Anlage von Stadtstraßen - RASt 06. FGSV-Verlag. Köln (FGSV, 200). Vallée, Dirk; Engel, Barbara; Vogt, Walter (2021) Stadtverkehrsplanung Band 3, Springer Verlag. Berlin.

Module M1629: Geoinformation Science

Courses

Title	Typ	Hrs/wk	CP
Introduction to Geoinformation Science (L2465)	Project-/problem-based Learning	3	3

Module Responsible	Prof. Peter Fröhle
Admission Requirements	None
Recommended Previous Knowledge	Principles of analysis and linear algebra
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are able to define the tasks and terms from the field of application of geo information systems. They can report the basics, the basic approaches and methods of geo information systems and are able to transfer these to practical questions.
Skills	Students are able to apply the basic methods used in geo-information systems to practical problems. They are able to apply them to simple applications of geographic information systems and to transfer them to other problems. The students can process a simple GIS project and present their results.
Personal Competence	
Social Competence	The students can work together groups cooperatively and productively.
Autonomy	Students are able to organize their work flow to prepare themselves before presentations and discussion. They can acquire appropriate knowledge by making enquiries independently.
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Credit points	3
Course achievement	None
Examination	Subject theoretical and practical work
Examination duration and scale	Computer aided GIS-Application and written-theoretical part
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Compulsory

Course L2465: Introduction to Geoinformation Science

Typ	Project-/problem-based Learning
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Yohannis Tadesse
Language	DE
Cycle	SoSe
Content	• Theoretical basics of Geo-Information-Systems • Data models, geographical coordinates, geo-referencing, map-views • Data mining and -analyses of geo-data • Analysis techniques
Literature	

Module M1630: Sanitary Engineering II

Courses

Title	Typ	Hrs/wk	CP
Management of Wastewater Infrastructure (L2467)	Seminar	2	3
Drinking Water Treatment (L2466)	Seminar	2	3

Module Responsible	Prof. Mathias Ernst
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge in the field of drinking water supply and waste water disposal.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can examplify their expert knowledge on drinking water, waste water treatment and the associated infrastructure systems. They are capable of reproducing the relevant empiricals assumptions and scientific simplifcations in detail. The students can model some processes mathematically. They can also assess existing problems in the field of sanitary engineering, such as removal of nitrate, and place them in a socio-political context. Furthermore, they know how to draft the features and effectiveness of important technologies of the future such as high- and low-pressure membrane filtration systems and techniques.
Skills	The students are able to apply the relevant standards and guidelines for the design and operation of urban water infrastructures independently. Their expertise comprises expert skills to design drinking water supply and urban drainage systems as well as the associated treatment facilities. Besides the acquirement of technical skills the students are able to address and solve biochemical problems in the filed of drinking water and wastewater treatment. The students are also able to develop ideas of their own to improve the existing water related infrastructures, systems and concepts.
Personal Competence	
Social Competence	The students are able to develop a specific topic in a team and to work out milestones according to a given plan.
Autonomy	Students are in a position to work on a subject and to organize their work flow independently. They can also present on this subject.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Subject theoretical and practical work
Examination duration and scale	Written-theoretical part and modelling
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Water and Environmental Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Water Technologies: Elective Compulsory

Course L2467: Management of Wastewater Infrastructure

Typ	Seminar
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Ralf Otterpohl
Language	DE
Cycle	SoSe
Content	The seminar ""Infrastructure Management Wastewater"" develops the understanding of infrastructure systems in relation to wastewater systems, but also addresses other infrastructure systems. Initially, an overview of the entire system is given, including water catchment areas, water distribution, the origin of wastewater in households and industry, stormwater runoff management, and the treatment and reuse of water (constituents). Thereby the design tools especially of digital modelling are understood by practical application. Energetic considerations as well as planning and restoration of pipeline systems are covered. For wastewater treatment, the basis developed in Sanitary Engineering I will be deepened and significantly expanded, especially the resource recovery of nutrients and water. Sanitary solutions for different socio-economic and climatic conditions are understood and calculated.
Literature	Gujer, W. (2007): Siedlungswasserwirtschaft, Springer, Berlin Heidelberg Metcalf and Eddy (2003): Wastewater Engineering : Treatment and Reuse, Boston, McGraw-Hill Henze, M. (1997): Wastewater Treatment : Biological and Chemical Processes, Berlin, Springer Stein D., Stein R. (2014): Instandhaltung von Kanalisationen, Verlag Prof. Dr.-Ing. Stein & Partner GmbH Wossog, G. (2016): Handbuch für den Rohrleitungsbau Band 1 und 2 Deutsche Vereinigung für Wasserwirtschaft, Abwasser und Abfall (2009): Abwasserableitung : Bemessungsgrundlagen, Regenwasserbewirtschaftung, Fremdwasser, Netzsanierung, Grundstücksentwässerung, Weimar, Univ.-Verl. DWA Arbeitsblätter

Course L2466: Drinking Water Treatment	
Typ	Seminar
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Mathias Ernst, Dr. Klaus Johannsen
Language	DE
Cycle	SoSe
Content	The seminar deepens and expands the knowledge of the processes of drinking water treatment. The seminar deals with ion exchange, oxidation, disinfection, gas exchange and hybrid treatment processes. Further topics include pH adjustment and energy efficiency in water supply. Within the scope of the course, the students work out a seminar performance (presentation, design, modelling) on the basis of a task.
Literature	Worch, E. (2019): Drinking Water Treatment, De Gruyter-Verlag Worch, E. (2015): Hydrochemistry, De Gruyter-Verlag Jekel, M., Czekalla, C. (2016): Wasseraufbereitung - Grundlagen und Verfahren (DVGW Lehr- und Handbuch Wasserversorgung, Band 6), DIV Deutscher Industrieverlag

Module M0612: Steel Structures II

Courses

Title	Typ	Hrs/wk	CP
Steel Structures II (L0301)	Lecture	2	3
Steel Structures II (L0302)	Recitation Section (large)	2	3

Module Responsible	Prof. Marcus Rutner
Admission Requirements	None
Recommended Previous Knowledge	Steel Structures I
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After successful completition students can • describe and explain the behaviour of bolted and welded connections • design and check simple halls and buildings • calculate forces and stresses of simple structures (trusses, beams, frames) • illustrate and dimension he main details (framework, column base, load application points)
Skills	Students are able to design simple structures and connections, describe the load distribution and recognize the possible modes of failure. They can apply structural imperfections, calculate according to 2nd order theory and verify their results.
Personal Competence	
Social Competence	--
Autonomy	--
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	120 minutes
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory

Course L0301: Steel Structures II

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	SoSe

Content	• Welded connections
	• Simple constructions
	  ◦ Trusses
	  ◦ Plate girders
	  ◦ Frames
	  ◦ Columns
	• Buildings with several storeys
	• Halls

Literature	Petersen, C.: Stahlbau, 4. Auflage 2013, Springer-Vieweg Verlag Wagenknecht, G.: Stahlbau-Praxis nach Eurocode 3, Bauwerk-Verlag 2011 • Band 1 Tragwerksplanung, Grundlagen • Band 2 Verbindungen und Konstruktionen

Course L0302: Steel Structures II

Typ	Recitation Section (large)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Marcus Rutner
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0985: Introduction to Railways

Courses

Title	Typ	Hrs/wk	CP
Introduction to Railways (L1184)	Lecture	2	4
Introduction to Railways (L1185)	Recitation Section (large)	1	2

Module Responsible	Prof. Carsten Gertz
Admission Requirements	None
Recommended Previous Knowledge	none
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can... • give definitions for basic terms related to railways • explain specifics concerning the handling of goods on railways • explain the required infrastructure • describe the work at the track super structure
Skills	--
Personal Competence	
Social Competence	Students can... • work at tasks in groups and come to results together • discuss contents in groups, summarize them and present them in front of others • convey contents to other by processing them in writing
Autonomy	Students can work out and understand contents themselves during the lecture through literature research
Workload in Hours	Independent Study Time 138, Study Time in Lecture 42
Credit points	6
Course achievement	None
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory

Course L1184: Introduction to Railways

Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	André Schoppe
Language	DE
Cycle	SoSe
Content	Lecture: The module provides a basic knowledge of the field of railroad engineering. An overview of railroad operations, control and safety technology, railroad superstructure, structural engineering, project management as well as maintenance and design of infrastructure facilities is given. The aim of this module is to give students as much insight as possible into railroad infrastructure. The module is examined by means of a written exam at the end of the semester. Lecture Hall Exercise: In order to give the students practical examples, full-day practical excursions are carried out. New handling techniques and currently available hardware will be presented by visiting the marshalling yard "die Zugbildungsanlage Maschen (ZBA)". Furthermore, the training center for track construction and civil engineering as well as the operations center in Hanover will be visited, where facilities and tasks will be presented. Questionnaires will also be provided for practice purposes. In addition, study papers can be handed out and supervised as required.
Literature	Die maßgebliche Literatur wird in StudIP veröffentlicht. Weitere Hinweise werden in der Veranstaltung gegeben.

Course L1185: Introduction to Railways	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	André Schoppe
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1633: Planning Law and Environmental Law/ Sustainable Urban Development

Courses

Title	Typ	Hrs/wk	CP
Sustainable Urban Development (L2474)	Lecture	2	3
Planning law and Environmental law (L2473)	Lecture	2	3

Module Responsible	Prof. Ralf Otterpohl
Admission Requirements	None
Recommended Previous Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence *Knowledge* *Skills* **Personal Competence** *Social Competence* *Autonomy*	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Subject theoretical and practical work
Examination duration and scale	Written-theoretical part and report
Assignment for the Following Curricula	Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory Engineering and Management - Major in Logistics and Mobility: Specialisation Traffic Planning and Systems: Elective Compulsory

Course L2474: Sustainable Urban Development

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Irene Peters
Language	DE
Cycle	SoSe
Content	
Literature	

Course L2473: Planning law and Environmental law

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Martin Wickel
Language	DE
Cycle	SoSe
Content	
Literature	

Module M1723: Building Information Modeling

Courses

Title	Typ	Hrs/wk	CP
Building Information Modeling (L2760)	Integrated Lecture	2	2
Building Information Modeling (L2761)	Recitation Section (small)	2	4

Module Responsible	Prof. Kay Smarsly
Admission Requirements	None
Recommended Previous Knowledge	None
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The contents of this module follow the recommendations of the German Association of Computing in Civil Engineering (www.gacce.de) for the BIM courses taught at German universities in the subject area of engineering informatics. The module aims to present methodological knowledge to enable students to introduce, to design, to monitor, and to improve BIM processes in companies and public institutions. An in-depth understanding of the methods and technologies relevant to BIM is essential. Emphasis is placed on generally valid principles and techniques independent of specific software products and valid for several decades. The theoretical content taught in the lecture is complemented by practical exercises, in which state-of-the-art software tools will be used. Topics include computer-aided design and geometry modeling, digital modeling of buildings and infrastructure, BIM data exchange and cooperation (focusing on Industry Foundation Classes), process modeling, job descriptions and BIM applications, BIM tools, and advanced aspects. A central component of this module will be a project work.
Skills	
Personal Competence	
Social Competence	
Autonomy	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Course achievement	None
Examination	Written elaboration
Examination duration and scale	Description of a BIM model with 15-minute oral presentation
Assignment for the Following Curricula	Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory

Course L2760: Building Information Modeling

Typ	Integrated Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Kay Smarsly
Language	DE
Cycle	SoSe
Content	• Historical development • Introduction and motivation • Basics of geometry • 2D geometry modeling • 2½D geometry modeling • 3D geometry modeling • Digital modeling of buildings and infrastructure, object-oriented, semantic, and parametric modeling • Data exchange, interoperability, and communication (with emphasis on Industry Foundation Classes) • BIM data storage and data management • Process modeling • Job profiles and applications • BIM tools • Advanced aspects of BIM • Seminar by external BIM experts and project presentations
Literature	

Course L2761: Building Information Modeling

Typ	Recitation Section (small)
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Kay Smarsly
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M1632: Applied Water Management

Courses

Title	Typ	Hrs/wk	CP
Nature-oriented Hydraulic Engineering (L2472)	Project-/problem-based Learning	2	2
Numerical modelling of soil water dynamics (L2471)	Project-/problem-based Learning	2	2
Numerical modelling of soil water dynamics (L2470)	Lecture	2	2

Module Responsible	Prof. Peter Fröhle
Admission Requirements	None
Recommended Previous Knowledge	• Basic knowledge of analysis and differential equations • hydromechanical and hydraulic engineering principles
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to define the basic tasks and terms of nature-oriented hydraulic engineering und groundwater hydrology. They cam describe the basics concepts, the basic approaches and methods of nature-oriented hydraulic engineering, groundwater hydrology and groundwater modelling and are able to apply these to practical problems.
Skills	The students are able to apply the methods and approaches of nature-oriented hydraulic engineering and of groundwater hydrology to practical problems. They can demonstrate to transfer and apply these to simple hydraulic engineering systems. In addition, they are able to apply the approaches commonly used in groundwater hydrology. They can exemplarily explain and reason how to apply them as a basis for geo-hydrological questions. In addition, students can apply basic groundwater modelling methods to simple problems of groundwater movement and groundwater recharge.
Personal Competence	
Social Competence	Students are able to help each other solving case studies. The students are able to deploy their gained knowledge in applied problems of the practical nature-based hydraulic engineering. Additionaly, they will be able to demonstrate to work cooperatively in teams consisting of engineers from different subject areas.
Autonomy	The students will be able to independently extend their knowledge and apply it to new problems.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Course achievement	None
Examination	Subject theoretical and practical work
Examination duration and scale	Written-theoretical part and modeling
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Green Technologies, Focus Water and Environmental Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Civil Engineering: Elective Compulsory Civil- and Environmental Engineering: Specialisation Traffic and Mobility: Elective Compulsory Civil- and Environmental Engineering: Specialisation Water and Environment: Elective Compulsory Green Technologies: Energy, Water, Climate: Specialisation Water Technologies: Elective Compulsory

Course L2472: Nature-oriented Hydraulic Engineering

Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Peter Fröhle
Language	DE
Cycle	SoSe
Content	• Regime-theory and application for the development of environmental guiding priciples of rivers • Engineering-biological measures for the stabilization of rivers • design techniques for water engineering • hydraulic dimensioning of river bed and bank protection • design principles and design techniques for fish passages (fish ladder, ramps etc.)
Literature	

Course L2471: Numerical modelling of soil water dynamics

Typ	Project-/problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Hannes Nevermann
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L2470: Numerical modelling of soil water dynamics	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Milad Aminzadeh
Language	EN
Cycle	SoSe
Content	• Hydrologic water bilance • aquifertyps • groundwater velocities • Darcy law • groundwater contour lines • storage capacity • flow equation • pumping tests • method of Beyer • solute transport in groundwater • Basics and theoretical background of simulation methods for the analysis of water movement in vadose zone • groundwater recharge
Literature	Todd, K. (2005): Groundwater Hydrology Fetter, C. W. (2001): Applied Hydrogeology Hölting, B. & Coldewey, W. (2005): Hydrogeologie Charbeneau, R. J. (2000): Groundwater Hydraulics and pollutant Transport

Thesis

Module M-001: Bachelor Thesis

Courses

Title	Typ	Hrs/wk	CP

Module Responsible	Professoren der TUHH
Admission Requirements	• According to General Regulations §21 (1): At least 126 ECTS credit points have to be achieved in study programme. The examinations board decides on exceptions.
Recommended Previous Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• The students can select, outline and, if need be, critically discuss the most important scientific fundamentals of their course of study (facts, theories, and methods). • On the basis of their fundamental knowledge of their subject the students are capable in relation to a specific issue of opening up and establishing links with extended specialized expertise. • The students are able to outline the state of research on a selected issue in their subject area.
Skills	• The students can make targeted use of the basic knowledge of their subject that they have acquired in their studies to solve subject-related problems. • With the aid of the methods they have learnt during their studies the students can analyze problems, make decisions on technical issues, and develop solutions. • The students can take up a critical position on the findings of their own research work from a specialized perspective.
Personal Competence	
Social Competence	• Both in writing and orally the students can outline a scientific issue for an expert audience accurately, understandably and in a structured way. • The students can deal with issues in an expert discussion and answer them in a manner that is appropriate to the addressees. In doing so they can uphold their own assessments and viewpoints convincingly.
Autonomy	• The students are capable of structuring an extensive work process in terms of time and of dealing with an issue within a specified time frame. • The students are able to identify, open up, and connect knowledge and material necessary for working on a scientific problem. • The students can apply the essential techniques of scientific work to research of their own.
Workload in Hours	Independent Study Time 360, Study Time in Lecture 0
Credit points	12
Course achievement	None
Examination	Thesis
Examination duration and scale	According to General Regulations
Assignment for the Following Curricula	General Engineering Science (German program): Thesis: Compulsory General Engineering Science (German program, 7 semester): Thesis: Compulsory Civil- and Environmental Engineering: Thesis: Compulsory Bioprocess Engineering: Thesis: Compulsory Chemical and Bioprocess Engineering: Thesis: Compulsory Computer Science: Thesis: Compulsory Data Science: Thesis: Compulsory Digital Mechanical Engineering: Thesis: Compulsory Electrical Engineering: Thesis: Compulsory Engineering Science: Thesis: Compulsory General Engineering Science (English program): Thesis: Compulsory General Engineering Science (English program, 7 semester): Thesis: Compulsory Green Technologies: Energy, Water, Climate: Thesis: Compulsory Computer Science in Engineering: Thesis: Compulsory Integrated Building Technology: Thesis: Compulsory Logistics and Mobility: Thesis: Compulsory Mechanical Engineering: Thesis: Compulsory Mechatronics: Thesis: Compulsory Naval Architecture: Thesis: Compulsory Technomathematics: Thesis: Compulsory Teilstudiengang Lehramt Metalltechnik: Thesis: Compulsory Process Engineering: Thesis: Compulsory Engineering and Management - Major in Logistics and Mobility: Thesis: Compulsory