Modulhandbuch/Module-Handbook

M. Sc. Resilient Civil Engineering

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Compulsory Courses
Module: Structural Dynamics

Module	Structural Dynamics
Module ID	3012585
Module level	Master
Subtitle	SDYN
Lecture	See list of lectures and examinations of the module
Semester allocation	1
Person in charge	Prof. Dr. Sven Klinkel
Lecturer	Prof. Dr. Sven Klinkel
Language	English
Assignment to the curriculum	Compulsory Module
Recommended requirements	None
Participation requirements (study program specific)	None
Teaching form	Examination, Lecture, Exercise
Examination mode	The course grade will be determined based on one of the following modes of evaluation: (A) Written examination (Klausur, 100% graded, 75 min.) (B) Oral examination (mündliche Prüfung, 100% graded, 30 min.) The final mode of evaluation (A or B) will be announced and publicly displayed prior to the first class-session. In general, grading for this class will be based on mode (A).
Workload	Total 150 h, Lecture hours 45 h (4 SWS), Self-study 105 h
Lecture hours	4 SWS
ECTS-Credit Points (CP)	5
Learning objectives	<u>Knowledge / Understanding</u> Students… • understand how to discretize structures and identify dynamic loads. • get detailed information about the calculation methods. • know the basics about nonlinear systems, damping models and random vibrations. <u>Abilities / Skills</u> Students…

	• use time and frequency-domain based calculation methods. • use computational methods to investigate the design of structures under dynamic loading. Competencies Students • calculate the dynamic response of structures. • identify the natural frequencies and mode shapes of structures.
Content	• Single-degree-of-freedom systems • Multi-degree-of-freedom systems • Systems with distributed mass and stiffness • Frequency domain methods • Time domain methods • Nonlinear systems • Damping models • Random vibrations
Media	RWTHmoodle
Literature	

Lectures / Examinations

Title	**ECTS**	**Workload**		**Duration of Exam (min)**
		Lecture h. (SWS)	**Self-Study (h)**	
Examination: Structural Dynamics	5	0	0	See above
Lecture: Structural Dynamics	0	2	52,5	0
Exercise: Structural Dynamics	0	2	52,5	0

Teaching Unit / Examinations: Examination Structural Dynamics

Title	Examination Structural Dynamics
Sub-title	Exa SDYN
Semester allocation	1
Connection to the curriculum	Compulsory Module

Teaching Unit / Examinations: Lecture Structural Dynamics

Title	Lecture Structural Dynamics
Sub-title	L SDYN
Semester allocation	1
Connection to the curriculum	Compulsory Module

Teaching Unit / Examinations: Exercise Structural Dynamics	
Title	Exercise Structural Dynamics
Sub-title	E SDYN
Semester allocation	1
Connection to the curriculum	Compulsory Module

Module: Probabilistic Design Methods and Safety

Module	Probabilistic Design Methods and Safety
Module ID	
Module level	Master
Subtitle	PDMS
Lecture	See list of lectures and examinations of the module
Semester allocation	1
Person in charge	Prof. Dr. Frank Kemper
Lecturer	Prof. Dr. Frank Kemper
Language	English
Assignment to the curriculum	Compulsory Module
Recommended requirements	None
Participation requirements (study program specific)	None
Teaching form	Examination, Lecture, Exercise
Examination mode	Written examination (Klausur, 100% graded)
Workload	Total 150 h, Lecture hours 45 h (4 SWS), Self-study 105 h
Lecture hours	4 SWS
ECTS-Credit Points (CP)	5
Learning objectives	<u>Knowledge / Understanding</u> Students… • know the safety concept of the Eurocode design standard for buildings. • can distinguish between different levels: deterministic, semi-probabilistic and full probabilistic and explain its backgrounds. <u>Abilities / Skills</u> Students… • are able to perform a structural design with semi and full probabilistic methods. • are able to determine the probability of failure based on probabilistic methods. <u>Competencies</u> Students… • can apply different probabilistic design methods.

	• can discuss the term structural safety in a wider sense.
Content	Probabilistic Design Methods and Safety covers the statistical background of design methods in civil engineering and introduces different methods for a more detailed determination of structural safety and the probability of failure.
Media	RWTHmoodle
Literature	

Lectures / Examinations

Title	**ECTS**	**Workload**		**Duration of Exam (min)**
		Lecture h. (SWS)	**Self-Study (h)**	
Examination: Probabilistic Design Methods and Safety	5	0	0	See above
Lecture: Probabilistic Design Methods and Safety	0	2	52,5	0
Exercise: Probabilistic Design Methods and Safety	0	2	52,5	0

Teaching Unit / Examinations: Examination Probabilistic Design Methods and Safety

Title	Examination Probabilistic Design Methods and Safety
Sub-title	Exa PDMS
Semester allocation	1
Connection to the curriculum	Compulsory Module

Teaching Unit / Examinations: Lecture Probabilistic Design Methods and Safety

Title	Lecture Probabilistic Design Methods and Safety
Sub-title	L PDMS
Semester allocation	1
Connection to the curriculum	Compulsory Module

Teaching Unit / Examinations: Exercise Probabilistic Design Methods and Safety

Title	Exercise Probabilistic Design Methods and Safety
Sub-title	E PDMS
Semester allocation	1
Connection to the curriculum	Compulsory Module

Module: Timber Structures I

Module	Timber Structures I
Module-ID	3011867
Module level	Master
Subtitle	TSTRI
Lecture	See list of lectures and examinations of the module
Semester allocation	1
Person in charge	Prof. Dr. Benno Hoffmeister
Lecturer	Prof. Dr. Benno Hoffmeister
Language	English
Assignment to the curriculum	Compulsory Module
Recommended requirements	None
Participation requirements (study program specific)	None
Teaching form	Examination, Lecture, Exercise
Examination mode	Graded written exam. Admission requirements for participation in the written exam is passed homework.
Workload	Total 150 h, Lecture hours 45 h (4 SWS), Self-study 105 h
Lecture hours	4 SWS
ECTS-Credit Points (CP)	5
Learning objectives	• Understanding of structural behavior of timber and its properties • Understanding the safety concept of timber structures • Skill of selection appropriate structural systems of timber • Skill of analysis and calculation of 2D or 3D bearing structures of timber • Skill of timber compatible construction of connections and simple details • Knowledge of required proofs: Cross section capacity; Stability (lateral buckling, flexual buckling) • Design of connections • Knowledge of typical roof structures its capacity and proofs
Content	• Timber as a building material: properties, classification, safety concept EN 1995. • Solid wood and glued-laminated timber as building material: Mechanical behavior, design values.

	• Structural timber systems: boundary conditions, assessment of internal forces and deformation. • Design of timber cross sections. • Stability of timber components: lateral buckling, flexual buckling of simple beams. • Built-up sections. • Fastener: nails, peg-shaped steel-connections (nails, bolts, dowels), proprietary connector, nail plates. • Connections: Carpenter connections. • Timber compatible construction with connections. • Simple verifications of pencil-shaped connections. • Complex verifications of rod shaped connections und proprietary connectors; Application and proof of nail plate connections; Roof structures
Media	RWTHmoodle
Literature	Umdruck: Grundlagen des Holzbaus; Vorlesungsmitschriften; Übungshandout Werner, G., Zimmer, K.: (2008): Holzbau 1, 4. überarbeitete Auflage, Springer-Berlag, Berlin,Heidelberg, New York Werner, G., Zimmer, K.: (2008): Holzbau 2, 4. überarbeitete Auflage, Springer-Verlag, Berlin, Heidelberg, New York Leonardo da Vinci Pilot Projekt 'Lehr- und Lernunterlagen für die Bemessung und Konstruktion von Tragwerken aus Holz - TEMTIS', Handbuch 1 - Tragwerke aus Holz, Handbuch 2 - Nachweisführung für Tragwerke aus Holz nach Eurocode 5, 2008

Lectures / Examinations

Title	ECTS	Workload		Duration of Exam (min)
		Lecture h. (SWS)	Self-Study (h)	
Examination: Timber Structures I	5	0	0	See above
Lecture: Timber Structures I	0	2	52,5	0
Exercise: Timber Structures I	0	2	52,5	0

Teaching Unit / Examinations: Examination Timber Structures I

Title	Examination Timber Structures I
Sub-title	Exa TSTRI
Semester allocation	1
Connection to the curriculum	Compulsory Module

Teaching Unit / Examinations: Lecture Timber Structures I

Title	Lecture Timber Structures I

Sub-title	L TSTRI
Semester allocation	1
Connection to the curriculum	Compulsory Module
Teaching Unit / Examinations: Exercise Timber Structures I	
Title	Exercise Timber Structures I
Sub-title	E TSTRI
Semester allocation	1
Connection to the curriculum	Compulsory Module

Module: Mechanics of Engineering Materials

Module	Mechanics of Engineering Materials
Module ID	3017572
Module level	Master
Subtitle	MEM
Lecture	See list of lectures and examinations of the module
Semester allocation	1
Person in charge	Prof. Dr.-Ing. habil. Jaan-W. Simon
Lecturer	Prof. Dr.-Ing. habil. Jaan-W. Simon
Language	English
Assignment to the curriculum	Compulsory module
Recommended requirements	None
Participation requirements (study program specific)	None
Teaching form	Examination, Lecture, Exercise
Examination mode	The course grade will be determined based on one of the following modes of evaluation: (A) Presentation (Referat, 50% graded) and written exam (Klausur, 50% graded, duration: 60 minutes); or (B) Presentation (Referat, 50% graded) and written (individual) paper (50% graded); or (C) Written exam (Klausur, 100% graded, 90 min.) The final mode of evaluation (A, B, or C) will be announced and publicly displayed prior to the first class-session. In general, grading for this class will be based on mode (C).
Workload	Total 150 h, Lecture hours 45 h (4 SWS), Self-study 105 h
Lecture hours	4 SWS
ECTS-Credit Points (CP)	5
Learning objectives	<u>Knowledge / Understanding</u> Students… • know the different phenomena which can be observed in experiments. • know the different material models which have been proposed to describe these phenomena.

	• understand the basic concept of how to achieve an appropriate material model. Abilities / Skills Students… • analyze analytical and numerical results with respect to the quality of the adopted model. • transfer theoretical models to actual engineering problems from the fields of mechanical, civil, and aeronautical engineering. • forecast the material response to a given loading scenario. Competencies Students… • critically assess the applicability and correctness of material models
Content	The course aims at the understanding of the behavior of engineering materials such as metals, plastics, and carbon fiber-reinforced composites. The major objective is the development and discussion of appropriate material models for elastic and inelastic materials. Further, the numerical treatment of these models will be addressed in the context of the finite element method. Finally, the according parameters will be identified by comparison with experiments. In particular, the following aspects will be addressed: • Elasticity at small and finite strains • Thermo-elasticity • Anisotropic elasticity for composites • Viscoelasticity – Creep an relaxation • Plasticity and hardening • Damage and crack initiation • Parameter identification
Media	Learning Space with videos and quizzes
Literature	Lecture Notes, students also receive a list of relevant literature

Lectures / Examinations

Title	**ECTS**	**Workload**		**Duration of Exam (min)**
		Lecture h. (SWS)	**Self-Study (h)**	
Examination: Mechanics of Engineering Materials	5	0	0	See above
Lecture: Mechanics of Engineering Materials	0	2	52,5	0
Exercise: Mechanics of Engineering Materials	0	2	52,5	0

Teaching Unit / Examinations: Examination Mechanics of Engineering Materials

Title	Examination Mechanics of Engineering Materials
Sub-title	Exa MEM
Semester allocation	1
Connection to the curriculum	Compulsory Module
Teaching Unit / Examinations: Lecture Mechanics of Engineering Materials	
Title	Lecture Mechanics of Engineering Materials
Sub-title	L MEM
Semester allocation	1
Connection to the curriculum	Compulsory Module
Teaching Unit / Examinations: Exercise Mechanics of Engineering Materials	
Title	Exercise Mechanics of Engineering Materials
Sub-title	E MEM
Semester allocation	1
Connection to the curriculum	Compulsory Module

Module: Environmental Sustainability in Transport Engineering

Module	Environmental Sustainability in Transport Engineering
Module ID	
Module level	Master
Subtitle	ESTE
Lecture	See list of lectures and examinations of the module
Semester allocation	1
Person in charge	Jun. Prof. Dr. Pengfei Liu
Lecturer	Jun. Prof. Dr. Pengfei Liu
Language	English
Assignment to the curriculum	Compulsory Module
Recommended requirements	None
Participation requirements (study program specific)	None
Teaching form	Examination, Lecture, Exercise
Examination mode	The final grade for this course will be based on the sum of the scores from the written paper (including presentation) and the final written examination: - Written paper, including presentation (Hausarbeit, 50% graded) - Written examination (Klausur, 50% graded, 60 min.) The written examination is open-book.
Workload	Total 150 h, Lecture hours 45 h (4 SWS), Self-study 105 h
Lecture hours	4 SWS
ECTS-Credit Points (CP)	5
Learning objectives	<u>Knowledge / Understanding</u> Students… • estimate air-pollution, emission levels, passive and active propagation of pollutants in the atmosphere • know planning concepts in development of ecologically sustainable transport systems • understand traffic noise generation and noise prediction methods • know about the rolling resistance, driving resistance and energy consumption <u>Abilities / Skills</u> Students

	• master analysis methods required for the assessment of air pollution of traffic and transport systems • master different methods used to determine noise exposure levels Competencies Students • critical thinking and problem-solving • collaboration with colleagues and leading by influence • effective oral and written communication • accessing and analyzing information
Content	• Pollutants: Gases, Particles • Pollutant Sources: Motor Vehicles Emissions, Train Emissions, Shipping • Emissions, Aircraft Emissions • Measurement and Data Analysis: Concentration Measurement of Gases, Concentration Measurement of Particles, Analysis of an Air-quality Data Set • Deposition: Dry Deposition Wet Deposition • Mitigation and Effects of Air Pollution: The Role of Vegetation, Effects on Humans and Animals, Effects on Plants, Soil and Groundwater, Effects on Materials • Control of Emission: EU legislation, UK legislation, US legislation, Legislation in Asian Regions • Noise: Introduction to Acoustics, The nature of environmental noise • Noise Sources: Motor Vehicles Emissions, Train Emissions, Aircraft Emissions • Measurement, Prediction, Propagation and Control of Noise: Noise Measurement; Prediction, Propagation and Control of Road Traffic Noise; Prediction, Propagation and Control of Railway Noise; Prediction, Propagation and Control of Airport Noise • Effects of Noise on Humans and Animals • Environmental assessment: Pollutant Assessment, Noise Assessment • Texture, Environment, Health: Rolling resistance, Driving resistance and Energy consumption
Media	RWTHmoodle
Literature	Tiwary, A. and Colls, J. (2010). Air Pollution: Measurement, Modelling and Mitigation, 3rd, Routledge, London.

Lectures / Examinations

Title	**ECTS**	**Workload**		**Duration of Exam (min)**
		Lecture h. (SWS)	**Self-Study (h)**	
Examination: Environmental Sustainability in Transport Engineering	5	0	0	See above
Lecture: Environmental Sustainability in Transport Engineering	0	2	52,5	0

Exercise: Environmental Sustainability in Transport Engineering	0	2	52,5	0

Teaching Unit / Examinations: Examination Environmental Sustainability in Transport Engineering	
Title	Examination Environmental Sustainability in Transport Engineering
Sub-title	Exa ESTE
Semester allocation	1
Connection to the curriculum	Compulsory Module
Teaching Unit / Examinations: Lecture Environmental Sustainability in Transport Engineering	
Title	Lecture Environmental Sustainability in Transport Engineering
Sub-title	L ESTE
Semester allocation	1
Connection to the curriculum	Compulsory Module
Teaching Unit / Examinations: Exercise Environmental Sustainability in Transport Engineering	
Title	Exercise Environmental Sustainability in Transport Engineering
Sub-title	E ESTE
Semester allocation	1
Connection to the curriculum	Compulsory Module

Module: Construction Planning and Realization

Module	Construction Planning and Realization
Module ID	
Module level	Master
Subtitle	CPR
Lecture	See list of lectures and examinations of the module
Semester allocation	1
Person in charge	Prof. Dr. Sabine Brück-Dürkop
Lecturer	Prof. Dr. Sabine Brück-Dürkop
Language	English
Assignment to the curriculum	Compulsory Module
Recommended requirements	None
Participation requirements (study program specific)	None
Teaching form	Examination, Lecture, Exercise
Examination mode	The course grade will be evaluated based on the following modes of evaluation: • Presentation (Referat, 50% graded) • Written (individual) paper (50% graded)
Workload	Total 150 h, Lecture hours 45 h (4 SWS), Self-study 105 h
Lecture hours	4 SWS
ECTS-Credit Points (CP)	5
Learning objectives	<u>Knowledge / Understanding</u> Students… • gain access to energetically sustainable and integral building planning. • represent the performative architectural form-finding process by simulation and visualization in a team, with the focus on the consideration of the most diverse sustainability criteria. • understand planning, under the aspect of defined sustainability goals, as a cooperative process. • document, analyze and practice the design process, using various planning parameters and applications, and assign it to the various actors in the process. • learn about integral energy and fire protection concepts, the processes of energetic form finding, building information

	management, simulation, automation, the construction process, and cost calculation. Abilities / Skills Students… • are familiar with planning process and planning Economy in the performance of sustainable goals.
Content	We pursue basic knowledge of the planning culture of buildings, while the following questions are put into context: • Which sustainability aspect can and should be considered where and when? • How can I incorporate the diverse requirements into the process? • What instruments do I have at my disposal? • What do the certification systems actually say and which one is considered when? • What rules and laws need to be known and observed? • What are the special features when integrating sustainability aspects into the planning process?
Media	RWTHmoodle
Literature	

Lectures / Examinations

Title	**ECTS**	**Workload**		**Duration of Exam (min)**
		Lecture h. (SWS)	**Self-Study (h)**	
Examination: Construction Planning and Realization	5	0	0	See above
Lecture: Construction Planning and Realization	0	2	52,5	0
Exercise: Construction Planning and Realization	0	2	52,5	0

Teaching Unit / Examinations: Examination Construction Planning and Realization

Title	Examination Construction Planning and Realization
Sub-title	Exa CPR
Semester allocation	1
Connection to the curriculum	Compulsory Module

Teaching Unit / Examinations: Lecture Construction Planning and Realization

Title	Lecture Construction Planning and Realization
Sub-title	L CPR

Semester allocation	1
Connection to the curriculum	Compulsory Module
Teaching Unit / Examinations: Exercise Construction Planning and Realization	
Title	Exercise Construction Planning and Realization
Sub-title	E CPR
Semester allocation	1
Connection to the curriculum	Compulsory Module

Module: Structural Analysis and Computational Methods

Module	Structural Analysis and Computational Methods
Module ID	
Module level	Master
Subtitle	SACM
Lecture	See list of lectures and examinations of the module
Semester allocation	2
Person in charge	Prof. Dr. Sven Klinkel
Lecturer	Prof. Dr. Sven Klinkel
Language	English
Assignment to the curriculum	Compulsory Module
Recommended requirements	None
Participation requirements (study program specific)	None
Teaching form	Examination, Lecture, Exercise
Examination mode	The course grade will be determined based on one of the following modes of evaluation: (A) Written examination (Klausur, 100% graded, 75 min.) (B) Oral examination (mündliche Prüfung, 100% graded, 30 min.) The final mode of evaluation (A or B) will be announced and publicly displayed prior to the first class-session. In general, grading for this class will be based on mode (A).
Workload	Total 150 h, Lecture hours 45 h (4 SWS), Self-study 105 h
Lecture hours	4 SWS
ECTS-Credit Points (CP)	5
Learning objectives	<u>Knowledge / Understanding</u> Students… • have fundamental knowledge in the analytical calculation of planar and curved axisymmetric plates and shells • have deeper understanding of the finite element method, its derivation, application, and limits <u>Abilities / Skills</u> Students… • apply the finite element method on the basis of static structural analysis.

	• have good skills with Finite Element Programs and critical evaluation of the analysis result Competencies Students… • master the load carrying mechanisms of plates and shells
Content	Fundamentals of the analysis of plates and shells, disks and plates, membrane and bending theory of axisymmetric shells, fundamentals of differential geometry, introduction to the finite element method, exemplary derivation of selected element types, modelling with finite elements by means of practical examples, analysis of plates and shells based on closed solutions, static analysis of practical examples with finite elements.
Media	RWTHmoodle
Literature	

Lectures / Examinations

Title	**ECTS**	**Workload**		**Duration of Exam (min)**
		Lecture h. (SWS)	**Self-Study (h)**	
Examination: Structural Analysis and Computational Methods	5	0	0	See above
Lecture: Structural Analysis and Computational Methods	0	2	52,5	0
Exercise: Structural Analysis and Computational Methods	0	2	52,5	0

Teaching Unit / Examinations: Examination Structural Analysis and Computational Methods

Title	Examination Structural Analysis and Computational Methods
Sub-title	Exa SACM
Semester allocation	2
Connection to the curriculum	Compulsory Module

Teaching Unit / Examinations: Lecture Structural Analysis and Computational Methods

Title	Lecture Structural Analysis and Computational Methods
Sub-title	L SACM
Semester allocation	2
Connection to the curriculum	Compulsory Module

Teaching Unit / Examinations: Exercise Structural Analysis and Computational Methods

Title	Exercise Structural Analysis and Computational Methods
Sub-title	E SACM
Semester allocation	2
Connection to the curriculum	Compulsory Module

Module: Wind Engineering

Module	Wind Engineering
Module ID	
Module level	Master
Subtitle	WENG
Lecture	See list of lectures and examinations of the module
Semester allocation	2
Person in charge	Prof. Dr. Frank Kemper
Lecturer	Prof. Dr. Frank Kemper
Language	English
Assignment to the curriculum	Compulsory Module
Recommended requirements	None
Participation requirements (study program specific)	None
Teaching form	Examination, Lecture, Exercise
Examination mode	Written examination (Klausur, 100% graded)
Workload	Total 150 h, Lecture hours 45 h (4 SWS), Self-study 105 h
Lecture hours	4 SWS
ECTS-Credit Points (CP)	5
Learning objectives	<u>Knowledge / Understanding</u> Students… • can describe the background of natural wind as a structural loading. • can distinguish static and dynamic wind effects. <u>Abilities / Skills</u> Students… • can determine wind load recommendations for individual shapes. • can predict expected wind induced vibrations for individual structures. <u>Competencies</u> Students… • can develop concepts to determine realistic wind load models based on standards or additionally needed investigations
Content	Wind engineering covers the effects of the stochastic wind process with respect to extreme wind velocities, structural load admittance

	(aerodynamics) and the vulnerability of wind induced vibrations od structures.			
Media	RWTHmoodle			
Literature				
Lectures / Examinations				
Title	**ECTS**	**Workload**		**Duration of Exam (min)**
		Lecture h. (SWS)	**Self-Study (h)**	
Examination: Wind Engineering	5	0	0	See above
Lecture: Wind Engineering	0	2	52,5	0
Exercise: Wind Engineering	0	2	52,5	0
Teaching Unit / Examinations: Examination Wind Engineering				
Title	Examination Wind Engineering			
Sub-title	Exa WENG			
Semester allocation	2			
Connection to the curriculum	Compulsory Module			
Teaching Unit / Examinations: Lecture Wind Engineering				
Title	Lecture Wind Engineering			
Sub-title	L WENG			
Semester allocation	2			
Connection to the curriculum	Compulsory Module			
Teaching Unit / Examinations: Exercise Wind Engineering				
Title	Exercise Wind Engineering			
Sub-title	E WENG			
Semester allocation	2			
Connection to the curriculum	Compulsory Module			

Module: Innovative Concrete Constructions

Module	Innovative Concrete Constructions
Module ID	
Module level	Master
Subtitle	ICC
Lecture	See list of lectures and examinations of the module
Semester allocation	2
Person in charge	Dr.-Ing. Abedulgader Baktheer
Lecturer	Prof. Dr. habil. Rostislav Chudoba, Dr.-Ing. Abedulgader Baktheer
Language	English
Assignment to the curriculum	Compulsory Module
Recommended requirements	None
Participation requirements (study program specific)	None
Teaching form	Examination, Lecture, Exercise
Examination mode	The course grade will be evaluated based on the following modes of evaluation: • Seminar paper (Seminararbeit, 60% graded, 15 pages) • Written examination (Klausur, 40% graded, 90 min.)
Workload	Total 150 h, Lecture hours 45 h (4 SWS), Self-study 105 h
Lecture hours	4 SWS
ECTS-Credit Points (CP)	5
Learning objectives	<u>Knowledge / Understanding</u> Students… • understand the concept of fatigue as a failure mechanism in the lightweight civil engineering structures • are able to classify fatigue process zones in reinforced and prestressed concrete structures • know the experimental methods used to characterize fatigue behavior in concrete structures <u>Abilities / Skills</u> Students… • apply appropriate modeling hypotheses and techniques to simulate fatigue behavior in concrete structures

	• are able to conduct virtual fatigue experiments using computer simulations and software tools • are able to apply design concepts and strategies to enhance the high-cycle fatigue resistance of modern concrete structures Competencies Students… • utilize advanced modeling approaches to simulate and predict fatigue performance in reinforced concrete structures • are able to design structures considering fatigue loading and high-cycle fatigue resistance requirements
Content	• Introduction and Motivation: Introduction to fatigue as a failure mechanism in structural engineering • Fatigue Loading in Structures: Overview of low-cycle and high-cycle fatigue loading and understanding different fatigue failure modes. • Classification of Fatigue Process Zones: Classification of fatigue process zones in lightweight modern reinforced and prestressed concrete structures • Experimental Characterization Methods: Overview of techniques used to characterize fatigue behavior in structures through laboratory testing and analysis methods. • Modeling Hypotheses for Fatigue in Concrete Structures: Review of modeling approaches and challenges for fatigue in concrete structures and representing cyclic behavior in numerical models. • Advanced Modeling Approaches: Exploration of advanced modeling techniques for cyclic behavior in reinforced concrete structures using constitutive models and its application in nonlinear Finite Element Analysis. • Virtual Fatigue Experiments: Introduction to virtual fatigue experiments through computer simulations and an overview of software tools and simulation techniques. • Loading Sequence Effects: Understanding the influence of loading sequence on fatigue behavior and the importance of considering loading sequences in design. • Design Concepts for High-Cycle Fatigue Resistance Structures: Introduction to design principles and strategies for high-cycle fatigue-resistant structures, including considerations for enhanced fatigue performance. • Prospects for Innovative Fatigue-Resistant Structures: Discussion on emerging trends, advancements, new materials, technologies, and construction techniques for designing innovative fatigue-resistant structures.
Media	RWTHmoodle
Literature	

Lectures / Examinations

Title	**ECTS**	**Workload**		**Duration of Exam (min)**
		Lecture h. (SWS)	**Self-Study (h)**	
Examination: Innovative Concrete Constructions	5	0	0	See above

Lecture: Innovative Concrete Constructions	0	2	52,5	0
Exercise: Innovative Concrete Constructions	0	2	52,5	0

Teaching Unit / Examinations: Examination Innovative Concrete Constructions	
Title	Examination Innovative Concrete Constructions
Sub-title	Exa ICC
Semester allocation	2
Connection to the curriculum	Compulsory Module
Teaching Unit / Examinations: Lecture Innovative Concrete Constructions	
Title	Lecture Innovative Concrete Constructions
Sub-title	L ICC
Semester allocation	2
Connection to the curriculum	Compulsory Module
Teaching Unit / Examinations: Exercise Innovative Concrete Constructions	
Title	Exercise Innovative Concrete Constructions
Sub-title	E ICC
Semester allocation	2
Connection to the curriculum	Compulsory Module

Module: Sustainable Steel Structures

Module	Sustainable Steel Structures
Module ID	
Module level	Master
Subtitle	SSS
Lecture	See list of lectures and examinations of the module
Semester allocation	2
Person in charge	Dr. Helen Bartsch
Lecturer	Dr. Helen Bartsch
Language	English
Assignment to the curriculum	Compulsory Module
Recommended requirements	None
Participation requirements (study program specific)	None
Teaching form	Examination, Lecture, Exercise
Examination mode	The course grade will be determined based on one of the following modes of evaluation: (A) Written examination (Klausur, 100% graded) (B) Oral examination (mündliche Prüfung, 100% graded) The final mode of evaluation (A or B) will be announced and publicly displayed prior to the first class-session. In general, grading for this class will be based on mode (A).
Workload	Total 150 h, Lecture hours 45 h (4 SWS), Self-study 105 h
Lecture hours	4 SWS
ECTS-Credit Points (CP)	5
Learning objectives	Knowledge / Understanding Students… • understand the load-bearing behavior of steel components. • learn safe, cost-effective steel component design for resource-efficient use. • are able to identify advantageous fatigue construction methods. • understand steel component recycling and re-use possibilities. • Learn about the sustainability assessment of constructions. Abilities / Skills Students… • analyze steel material load bearing behavior

	• design safe, cost-effective steel components with resource efficiency • apply fatigue beneficial construction methods • Implement recycling and re-use of steel components. • Performing sustainability assessments and integrate criteria in construction <u>Competencies</u> Students… • conceive material efficient design of steel components • conceive fatigue beneficial design • manage sustainability assessment
Content	Load-bearing behavior of the steel building material; safe and simultaneously cost-effective design of steel components for resource-efficient material usage; Particularly beneficial fatigue construction methods; Utilization of recycling and direct re-use of steel components; Introduction to sustainability assessment and identification of key sustainability criteria in construction;
Media	RWTHmoodle
Literature	

Lectures / Examinations

Title	**ECTS**	**Workload**		**Duration of Exam (min)**
		Lecture h. (SWS)	**Self-Study (h)**	
Examination: Sustainable Steel Structures	5	0	0	See above
Lecture: Sustainable Steel Structures	0	2	52,5	0
Exercise: Sustainable Steel Structures	0	2	52,5	0

Teaching Unit / Examinations: Examination Sustainable Steel Structures

Title	Examination Sustainable Steel Structures
Sub-title	Exa SSS
Semester allocation	2
Connection to the curriculum	Compulsory Module

Teaching Unit / Examinations: Lecture Sustainable Steel Structures

Title	Lecture Sustainable Steel Structures
Sub-title	L SSS

Semester allocation	2
Connection to the curriculum	Compulsory Module
Teaching Unit / Examinations: Exercise Sustainable Steel Structures	
Title	Exercise Sustainable Steel Structures
Sub-title	E SSS
Semester allocation	2
Connection to the curriculum	Compulsory Module

Module: Sustainability for the Built Environment - GREEN2Construction

Module	Sustainability for the Built Environment - GREEN2Construction
Module ID	
Module level	Master
Subtitle	G2C
Lecture	See list of lectures and examinations of the module
Semester allocation	2
Person in charge	Dr. Stanimira Markova
Lecturer	Dr. Stanimira Markova
Language	English
Assignment to the curriculum	Compulsory Module
Recommended requirements	None
Participation requirements (study program specific)	None
Teaching form	Examination, Lecture, Exercise
Examination mode	The course grade will be based on the sum of one presentation per topic and the final written examination: - 4 presentations (Referat, 80% graded in total) - Written examination (Klausur, 20% graded, 60 min.)
Workload	Total 150 h, Lecture hours 45 h (4 SWS), Self-study 105 h
Lecture hours	4 SWS
ECTS-Credit Points (CP)	5
Learning objectives	<u>Knowledge / Understanding</u> Students… • gain a deep understanding in the various aspects and principles of sustainability • know the different aspects and topics of sustainability and how they impact and interact with each other • understand and apply measures and solutions for the improvement of the building design in one or more aspects of sustainability in a systematic way, without damaging others • recognize and avoid greenwashing • know the various building sustainability certifications, the similarities and differences, the potentials, and the limitations in their application <u>Abilities / Skills</u>

	Students… • identify, which sustainability aspects need to be addresses according to the requirements of the project. • identify, which method and tools to be applied in alignment with the identified relevant sustainability aspects (LCA, circularity optimization, recyclability potential estimation; Ökobaudat etc.) • identify and apply the optimal tool for the optimization towards a specific sustainability goal. • develop and formulate sustainability concepts with detailed workflows and measures for their implementation for a real building project. <u>Competencies</u> Students… • have expertise in and utilize confidently the principles, standards and approaches for sustainability modelling and optimization in the built environment • recognize and avoid greenwashing • apply various tools, supporting the sustainability optimization in the planning process, identifying weaknesses in the prospective sustainability performance of the building, and avoiding them in the planning process • develop a comprehensive sustainability concept for a building project (new and in refurbishment)
Content	What is sustainability? What does sustainability have to do with buildings and the built environment? How can I, as an engineer, influence the sustainable performance of a building? What are the individual aspects of sustainability and how do they relate and interconnect to each other? What are the requirements for sustainability in building design around the world? The course is aimed at students in the master's program. Students will get to know and apply the methods, the tools, and the set of standards of sustainable building design in various aspects of sustainability (climate protection, energy efficiency, resource efficiency, biodiversity etc.), in the situation of a real project. **Topic 1 - Sustainability - the foundations** In the first module, the basic concepts, and fundamentals of sustainability in general and sustainable building design are explained. Many important aspects of sustainability such as climate change, energy demand, and certifications are covered with associated methodologies such as life cycle assessment (LCA), energy accounting, resource efficiency, and circularity, etc. The differences and interrelationships between these will be explained in detail. Also in this module, the most common building sustainability certifications (e.g., DGNB, LEED, BNB), their scopes and differences are explained. The Topics are divided into three compulsory (climate change, energy efficiency, resource efficiency and circulatory) and eleven eligible topics. From the pool of eligible topics (flexibility and building transformability, life cycle costs, biodiversity, water as resource and as a threat, microclimate etc), the students can choose up to four additional topics for a total of seven topics for the semester. Students will be given the opportunity to choose the specific sustainability topics, which will be the focus of the work during

	the term and for which a detailed sustainability concept for a real project will be developed at the end of the class (Modul 4). **Topic 2 - Sustainability as a system** A very common problem in near-sustainable building design arises when considering, focusing, and solving a few isolated parameters of individual aspects of sustainability without considering the context and impact on other sustainability aspects. The resulting "isolated solutions" effectively solve the problem of focus, but in the process cause a host of other critical problems. An example of this are products and construction methods that have very high efficiency and performance in terms of energy balance and building energy performance, but at the same time cause critical environmental impacts, are not recyclable and lead to an enormous waste of resources and pose a risk to humans and the environment due to the content of substances and materials of concern. In this module, the focus is on the principles of systematic observation and consideration, the interrelationships between the measurable parameters of the individual sustainability aspects and the avoidance of isolated solutions and greenwashing. Other aspects of sustainability, both "classic" and "future-oriented", are presented and observed in their context and interaction. **Topic 3 – Digital Tools for the sustainability optimization** In this module the students will be given the opportunity to learn and apply various digital tools, which support the sustainability modelling and optimization in the design phase. Various tools will be presented, and the students will be given the choice, which one to learn and apply on a real project. Most of the tools are for the BIM-based planning process, therefore, basic skills in the principles of the planning process with BIM, as well as the familiarity with at least one BIM-design system, are required. **Topic 4- Development of a sustainability concept for a real project** Developing sustainability concepts as a part of a project has become one of the key tasks for every architect, designer, planer, and engineer, both in new building projects and in refurbishment projects. Based on the knowledge gathered in the previous modules, the student must develop their own sustainability concepts for two real competitions projects (new building and existing building).
Media	RWTHmoodle
Literature	Will be provided for each module; the lectures and the discussions will be recorded and provided to the students as learning material

Lectures / Examinations

Title	**ECTS**	**Workload**		**Duration of Exam (min)**
		Lecture h. (SWS)	**Self-Study (h)**	
Examination: Sustainability for the Built Environment - GREEN2Construction	5	0	0	See above
Lecture: Sustainability for the	0	2	52,5	0

Built Environment - GREEN2Construction				
Exercise: Sustainability for the Built Environment - GREEN2Construction	0	2	52,5	0

Teaching Unit / Examinations: Examination Sustainability for the Built Environment - GREEN2Construction	
Title	Examination Sustainability for the Built Environment - GREEN2Construction
Sub-title	Exa G2C
Semester allocation	2
Connection to the curriculum	Compulsory Module
Teaching Unit / Examinations: Lecture Sustainability for the Built Environment - GREEN2Construction	
Title	Lecture Sustainability for the Built Environment - GREEN2Construction
Sub-title	L G2C
Semester allocation	2
Connection to the curriculum	Compulsory Module
Teaching Unit / Examinations: Exercise Sustainability for the Built Environment - GREEN2Construction	
Title	Exercise Sustainability for the Built Environment - GREEN2Construction
Sub-title	E G2C
Semester allocation	2
Connection to the curriculum	Compulsory Module

Module: Structural Control and Health Monitoring

Module	Structural Control and Health Monitoring
Module ID	3017272
Module level	Master
Subtitle	SCHM
Lecture	See list of lectures and examinations of the module
Semester allocation	3
Person in charge	PD Dr.-Ing. habil. Okyay Altay
Lecturer	PD Dr.-Ing. habil. Okyay Altay
Language	English
Assignment to the curriculum	Compulsory Module
Recommended requirements	None
Participation requirements (study program specific)	None
Teaching form	Examination, Lecture
Examination mode	The course grade will be evaluated based on the following modes of evaluation: (A) written examination (100%, duration: 60 minutes) (B) oral examination (100%, duration: 30 minutes) The final mode of evaluation (A or B) will be announced and publicly displayed prior to the first class-session. In general, grading for the class will be based on mode (A).
Workload	Total 90 h, Lecture hours 22,5 h (2 SWS), Self-study 67,5 h
Lecture hours	2 SWS
ECTS-Credit Points (CP)	3
Learning objectives	<u>Knowledge / Understanding</u> This course gives the attendees a comprehensive overview of the latest developments of this highly innovative and interdisciplinary research field of structural control and health monitoring systems for important civil engineering structures. <u>Abilities / Skills</u> The course provides students with a useful tool set for the analytic, numeric, and experimental design of these systems. <u>Competencies</u>

	At the end of the course, the students gain the necessary skills for the implementation of structural control and health monitoring systems on high-rise buildings and other important civil infrastructure, such as bridges.
Content	Wind, traffic load and earthquake induced dynamic loading cause vibrations, which can jeopardize both the safety and the serviceability of structures. To prevent these vibrations, structural design should satisfy several requirements. On existing structures, a post implementation of these measures, lead generally to vastly extensive and prohibitive construction activities. Architectural and economical challenges motivated slender design makes it for modern structures impossible to fulfill the demands regarding the vibration protection. An example for this is the Millennium Bridge in London, which was closed shortly after the opening ceremony because of structural vibrations caused by dynamic pedestrian loads. In civil engineering practice for the mitigation of vibrations and to keep the slender character of the constructions supplementary dampers are used. These structural control systems can dissipate the oscillation energy of the structures like the car suspensions. To ensure the safety and serviceability criteria the high-rise buildings and other important civil infrastructure, which are usually under continuous dynamic loading, should be monitored and maintained permanently. Because of the enormous number of structures, this demand is a huge challenge for today's civil engineers. For instance, in Germany there are over 38.000 highway bridges, which are suffering under dynamic traffic loads. For the sake of the sustainability of these structures, structural health monitoring systems are being developed, which can permanently measure and evaluate the condition of a structure using high-tech sensors and data communication technologies. From these two topics "structural control" and "structural health monitoring" the keystones of the course are built up. The course includes the following subjects: Structural control: - Structural rehabilitation and retrofitting - Passive, active and semi-active damper systems - Anti-seismic devices - Principles of control engineering Structural health monitoring: - Sensor and actuator technology - Signal processing - System identification methods - Vibration measurement and evaluation - Condition monitoring
Media	RWTHmoodle
Literature	Altay O (2021): Vibration Mitigation Systems in Structural Engineering, CRC, ISBN 978-1-138-56416-9. Adams D E (2007): Health Monitoring of Structural Materials and Components, Wiley, ISBN 978-0-470-03313-5. Casciati F, Magonette G, Marazzi F (2006): Technology of Semiactive Devices and Applications in Vibration Mitigation, Wiley, ISBN 978-0-470-02289-4.

	Constantinou M C, Soong T T, Dargush G F (1998): Passive Energy Dissipation Systems for Structural Design and Retrofit, MCEER, ISBN 0-9656682-1-5. Hanson R D, Soong T T (2001): Seismic Design with Supplemental Energy Dissipation Devices, EERI, ISBN 0-943198-13-5. Karbhari V M, Ansari F (2009): Structural Health Monitoring of Civil Infrastructure Systems, Elsevier, ISBN 978-1-84569-392-3. Soong T T, Constantinou M C (1994): Passive and Active Structural Vibration Control in Civil Engineering, Springer, ISBN 3-211-82615-7. Soong T T, Dargush G F (1997): Passive Energy Dissipation Systems in Structural Engineering, Wiley, ISBN 978-0-471-96821-4.

Lectures / Examinations

Title	ECTS	Workload		Duration of Exam (min)
		Lecture h. (SWS)	Self-Study (h)	
Examination: Structural Control and Health Monitoring	3	0	0	See above
Lecture: Structural Control and Health Monitoring	0	2	67,5	0

Teaching Unit / Examinations: Examination Structural Control and Health Monitoring

Title	Examination Structural Control and Health Monitoring
Sub-title	Exa SCHM
Semester allocation	3
Connection to the curriculum	Compulsory Module

Teaching Unit / Examinations: Lecture Structural Control and Health Monitoring

Title	Lecture Structural Control and Health Monitoring
Sub-title	L SCHM
Semester allocation	3
Connection to the curriculum	Compulsory Module

Module: Earthquake Engineering

Module	Earthquake Engineering
Module ID	0521555
Module level	Master
Subtitle	EENG
Lecture	See list of lectures and examinations of the module
Semester allocation	3
Person in charge	Prof. Dr. Sven Klinkel
Lecturer	Prof. Dr. Sven Klinkel
Language	English
Assignment to the curriculum	Compulsory Module
Recommended requirements	None
Participation requirements (study program specific)	None
Teaching form	Examination, Lecture, Exercise
Examination mode	Written Examination (100 %) or Oral Examination (100 %)
Workload	Total 150 h, Lecture hours 45 h (4 SWS), Self-study 105 h
Lecture hours	4 SWS
ECTS-Credit Points (CP)	5
Learning objectives	Fundamentals of earthquake engineering with emphasis on design of seismic resistant structures Knowledge / Understanding Students… • understand how to define seismic load; • know different types of seismic analysis; • know the basic principles of seismic design; • understand the relation of seismic hazard-vulnerability-risk; • know analytical methods for seismic vulnerability assessment. Abilities / Skills Students… • make use of linear and nonlinear seismic analysis of structures; • apply analytical methodologies for definition of seismic vulnerability. Competencies Students…

	• calculate the seismic response of structures; • define seismic vulnerability functions
Content	• Basic of structural analysis • Earthquakes; nature, intensity, measurements • Earthquake response of linear single-degree-of-freedom systems • Earthquake response of inelastic single-degree-of-freedom systems • Earthquake response of linear multi-degree-of-freedom systems • Earthquake response, design and evaluation of multistory buildings
Media	RWTHmoodle
Literature	Lecture Notes 1. K. Chopra: "Dynamics of Structures, Theory and Application to Earthquake Engineering", Prentice Hall, 2012 K. Meskouris, C. Butenweg, K.-G. Hinzen, R. Höffer: "Structural Dynamics with Applications in Earthquake and Wind Engineering" 2nd Ed. Springer 2019

Lectures / Examinations

Title	**ECTS**	**Workload**		**Duration of Exam (min)**
		Lecture h. (SWS)	**Self-Study (h)**	
Examination: Earthquake Engineering	5	0	0	See above
Lecture: Earthquake Engineering	0	2	52,5	0
Exercise: Earthquake Engineering	0	2	52,5	0

Teaching Unit / Examinations: Examination Earthquake Engineering

Title	Examination Earthquake Engineering
Sub-title	Exa EENG
Semester allocation	3
Connection to the curriculum	Compulsory Module

Teaching Unit / Examinations: Lecture Earthquake Engineering

Title	Lecture Earthquake Engineering
Sub-title	L EENG
Semester allocation	3
Connection to the curriculum	Compulsory Module

Teaching Unit / Examinations: Exercise Earthquake Engineering

Title	Exercise Earthquake Engineering
Sub-title	E EENG

Semester allocation	3
Connection to the curriculum	Compulsory Module

Module: Water Management and Resilience

Module	Water Management and Resilience
Module ID	
Module level	Master
Subtitle	WMR
Lecture	See list of lectures and examinations of the module
Semester allocation	3
Person in charge	Prof. Dr. Frank Kemper
Lecturer	Jens Reinert (M.Sc. RWTH Aachen)
Language	English
Assignment to the curriculum	Compulsory Module
Recommended requirements	None
Participation requirements (study program specific)	None
Teaching form	Examination, Lecture, Exercise
Examination mode	Project work with final presentation (100% graded)
Workload	Total 150 h, Lecture hours 45 h (4 SWS), Self-study 105 h
Lecture hours	4 SWS
ECTS-Credit Points (CP)	5
Learning objectives	<u>Knowledge / Understanding</u> Students… • understand water engineering as an interdisciplinary approach • learn the basics of system thinking and the concept of resilience • learn to balance the needs of water management with the demands of a more complicated world <u>Abilities / Skills</u> Students… • recognize interrelationships of issues beyond their own discipline • identify weaknesses in existing systems and thinking • learn how to identify and solve causes of problems on an as-needed basis <u>Competencies</u> Students… • develop concepts and derive recommendations for action to address analyzed sample issues

	• learn to present their results and to discuss them in group
Content	Water Resilience and water management, adaption and transformation, future ecosystem services, climatic drivers and stressors on water systems, Water governance, human dimensions of water, water ethics.
Media	RWTHmoodle
Literature	Julia Baird and Ryan Plummer (2021): Water Resilience – Management and Governance in Times of Change

Lectures / Examinations

Title	**ECTS**	**Workload**		**Duration of Exam (min)**
		Lecture h. (SWS)	**Self-Study (h)**	
Examination: Water Management and Resilience	5	0	0	See above
Lecture: Water Management and Resilience	0	2	52,5	0
Exercise: Water Management and Resilience	0	2	52,5	0

Teaching Unit / Examinations: Examination Water Management and Resilience

Title	Examination Water Management and Resilience
Sub-title	Exa WMR
Semester allocation	3
Connection to the curriculum	Compulsory Module

Teaching Unit / Examinations: Lecture Water Management and Resilience

Title	Lecture Water Management and Resilience
Sub-title	L WMR
Semester allocation	3
Connection to the curriculum	Compulsory Module

Teaching Unit / Examinations: Exercise Water Management and Resilience

Title	Exercise Water Management and Resilience
Sub-title	E WMR
Semester allocation	3
Connection to the curriculum	Compulsory Module

Module: Life Cycle Assessment

Module	Life Cycle Assessment
Module ID	
Module level	Master
Subtitle	LCA
Lecture	See list of lectures and examinations of the module
Semester allocation	3
Person in charge	Prof. Dr. Marzia Traverso
Lecturer	Prof. Dr. Marzia Traverso
Language	English
Assignment to the curriculum	Compulsory Module
Recommended requirements	None
Participation requirements (study program specific)	None
Teaching form	Examination, Lecture, Exercise
Examination mode	Written examination (Klausur, 50% graded), seminar with group presentation (50% graded)
Workload	Total 150 h, Lecture hours 45 h (4 SWS), Self-study 105 h
Lecture hours	4 SWS
ECTS-Credit Points (CP)	5
Learning objectives	<u>Knowledge / Understanding</u> Students… • get an overview over the existing methodologies and concepts in Life Cycle Sustainability Assessment. • understand the complexity of the evaluation of Sustainability due to trade-offs within the three-column approach (environmental, economic, social). <u>Abilities / Skills</u> Students… • are able to implement the methodologies cited above in different contexts and sectors to support decision-making process towards a more sustainable production and consumption <u>Competencies</u> Students…

	• are able to even further develop the named methodologies and adapt them to new evolving issues related to environmental and social impacts.
Content	Several methods have been developed in the last decades to assess the environmental and social Impact of a product along its life cycle primarily the ISO Norm 14040 and 14044. This lecture provides a detailed description (step-by-step) of these methodologies according to the current international and European standards e.g. Carbon or Water Footprint. Further the lecture introduces assessment methods, tools, and certification schemes for sustainable buildings such as DGNB and the European framework Level(s). Throughout the lecture, approaches and criteria to evaluate the sustainability performance of buildings in the three dimensions (environmental, economic, and social) are discussed. Particular focus is given to life cycle approaches in the construction sector, such as Life Cycle Assessment (LCA), Environmental Product Declaration (EPD) and Product Environmental Footprint (PEF).
Media	RWTHmoodle
Literature	

Lectures / Examinations

Title	**ECTS**	**Workload**		**Duration of Exam (min)**
		Lecture h. (SWS)	**Self-Study (h)**	
Examination: Life Cycle Assessment	5	0	0	See above
Lecture: Life Cycle Assessment	0	2	52,5	0
Exercise: Life Cycle Assessment	0	2	52,5	0

Teaching Unit / Examinations: Examination Life Cycle Assessment

Title	Examination Life Cycle Assessment
Sub-title	Exa LCA
Semester allocation	3
Connection to the curriculum	Compulsory Module

Teaching Unit / Examinations: Lecture Life Cycle Assessment

Title	Lecture Life Cycle Assessment
Sub-title	L LCA
Semester allocation	3
Connection to the curriculum	Compulsory Module

Teaching Unit / Examinations: Exercise Life Cycle Assessment	
Title	Exercise Life Cycle Assessment
Sub-title	E LCA
Semester allocation	3
Connection to the curriculum	Compulsory Module

Module: Future Sustainability

Module	Future Sustainability
Module ID	
Module level	Master
Subtitle	FSUS
Lecture	See list of lectures and examinations of the module
Semester allocation	3
Person in charge	Dr. Stanimira Markova
Lecturer	Dr. Stanimira Markova
Language	English
Assignment to the curriculum	Compulsory Module
Recommended requirements	Successful completionof the class “Sustainability for the Built Environment - Green2Construction”
Participation requirements (study program specific)	-
Teaching form	Examination, Lecture, Exercise
Examination mode	A problem is worked on in the form of a project. The module is assessed by: - regular interim reports (50%) - final presentation of the project results (Referat, 50%).
Workload	Total 150 h, Lecture hours 45 h (4 SWS), Self-study 105 h
Lecture hours	4 SWS
ECTS-Credit Points (CP)	5
Learning objectives	<u>Knowledge / Understanding</u> Students… • know about the current and future trends in sustainability development. • are capable to draw and understand scenarios in sustainability development • comprehend the possible impact a drawn scenario would have on building and the building process in near to mid-term future. • have comprehensive knowledge about the cutting edge technologies (state of art and state of research) and solutions for the building sustainability performance optimization from a multi-aspect perspective on material, building systems, building process, building and city quarter levels; knowledge of the implementation, the potentials and shortcomings of such technologies;

	Abilities / Skills Students • identify trends in the sustainability development regarding the built word • develop proactive solutions to address current and future challenges. • formulate solutions for the future trends and scenarios of the sustainability development corresponding with the expected impact and changes on the built environment (materials, processes, buildings, city quarters et) • understand the impact of the implementation of innovative technologies in a systemic context. • explore and formulate demand and concepts for new and improved solutions for the current and future sustainability scenarios on material, building systems, building process, building and city quarter levels.
Content	The built world has a tremendous impact on the environment. Buildings are considered the largest consumer of material and energy resources, the largest consumer of energy, and the largest producer of waste. As designers of the built environment, we determine the performance and the future impact of buildings on the environment. Many of these challenges have been known to science and industry for decades. However, it is no longer sufficient to act reactively against the most pressing problems that are already known. The climate and resource crisis, the biodiversity crisis, the availability of water as a resource - to name just a few - have arisen because industry and policymakers have tried to respond too late and only reactively to processes that are already irreversible in some cases. A "next" generation of sustainability and environmental challenges and looming imbalances are already emerging and are being dramatically impacted by the built world, construction activities - and processes. The main objective of the course is to expose students to the challenges of sustainability and sustainability development today and in the upcoming decades. The students have the opportunity to analyze, comprehend, and develop coherent future scenarios for the built world in the context of the future sustainability development, based on the current status quo and observed trends, and proactively address them through research, analysis and conceptualization of innovations and innovative solutions for all levels of the built world – building materials, building technologies, building processes, building concept and city quarters. The work throughout the semester is divided into smaller modules, beginning with input by the lecturer, followed by a conceptual solution development by the students in constant feedback cycle with the lecturer and finally concluded with an exemplary implementation of the concepts in a project environment.
Media	RWTHmoodle
Literature	Will be provided for each module; the lectures and the discussions will be recorded and provided to the students as learning material.

Lectures / Examinations

Title	**ECTS**	**Workload**		**Duration of Exam (min)**
		Lecture h. (SWS)	**Self-Study (h)**	

Examination: Future Sustainability	5	0	0	See above
Lecture: Future Sustainability	0	2	52,5	0
Exercise: Future Sustainability	0	2	52,5	0

Teaching Unit / Examinations: Examination Future Sustainability	
Title	Examination Future Sustainability
Sub-title	Exa FSUS
Semester allocation	3
Connection to the curriculum	Compulsory Module
Teaching Unit / Examinations: Lecture Future Sustainability	
Title	Lecture Future Sustainability
Sub-title	L FSUS
Semester allocation	3
Connection to the curriculum	Compulsory Module
Teaching Unit / Examinations: Exercise Future Sustainability	
Title	Exercise Future Sustainability
Sub-title	E FSUS
Semester allocation	3
Connection to the curriculum	Compulsory Module

Elective Courses – Projects
Module: Design Process of Building Construction Part I

Module	Design Process of Building Construction Part I
Module ID	
Module level	Master
Subtitle	DPBCI
Semester	2
Person in charge	Prof. Dr. Sabine Brück-Dürkop
Lecturer	Prof. Dr. Sabine Brück-Dürkop
Language	English
Assignment to the curriculum	Elective
Recommended requirements	none
Participation requirements (study program specific)	none
Teaching Form	Examination, independent project work
Examination mode	Presentation (Referat, 100% graded)
Workload	Total 90h, Practical Work 22,5h, Self-Study 67,5h
ECTS-Credit Points (CP)	3

Learning objectives	<u>Knowledge / Understanding</u>
	Students…
	• Complex projects require specific, success-oriented solution strategies. The design project is based on specific sustainable requirements from planning practice. Iterative procedures are practiced and here the interplay between the planning of its detailing with the special consideration of sustainability.
	• In addition, the following skills and abilities are taught:
	  ○ scientific working methods,
	  ○ Application possibilities of the most diverse, construction and planning-relevant scientific fields,
	  ○ to consider, control and integrate the services of others involved in the planning,
	  ○ Reconciling divergent factors, applying knowledge and integrating it holistically in creating a design solution.…

Content	The way the project work is carried out, i.e. the individual supervision, the discussion in groups at regular colloquia and the final public presentation

	promote the key competencies of the candidates, i.e. their ability to act independently, communicate and interact. Contents. In-depth courses that change every semester with a specific focus on key sustainability issues. A 2-semester project (module 1+module 2) with completion at the end of module 2. Its central object is to integrate sustainability aspects into a given building design draft. It contains synthetic-analytical and scientific components and questions that also contain innovation and research potential. The two-semester duration allows a comprehensive and at the same time intensive course of study, which enables the well-founded development of one's own specializations.
Media	-
Literature	

Lectures / Examinations

Title	**ECTS**	**Workload**		**Duration of Exam (min)**
		Lecture h (SWS)	**Self-Study (h)**	
Examination: Design Process of Building Construction Part I	3		90	See above
Practical Session: Design Process of Building Construction Part I		2	67,5	

Teaching Unit / Examinations: Examination Design Process of Building Construction Part I

Title	Design Process of Building Construction Part I
Sub-title	DPBC Part I
Semester	2
Connection to the curriculum	Elective Module

Module: FE Application in the Construction Practice Part I

Module	FE Application in the Construction Practice Part I
Module ID	
Module level	Master
Subtitle	FEACPI
Semester	2
Person in charge	Prof. Dr. Sven Klinkel
Lecturer	N.N.
Language	English
Assignment to the curriculum	Elective
Recommended requirements	none
Participation requirements (study program specific)	none
Teaching Form	Examination, independent project work
Examination mode	Presentation and oral examination (100% graded)
Workload	Total 90h, Practical Work 22,5h, Self-Study 67,5h
ECTS-Credit Points (CP)	3
Learning objectives	<u>Knowledge / Understanding</u> Students… • apply commercial software for modeling of beam constructions. • perform static and dynamic analysis and dimensioning of real-world examples. <u>Abilities / Skills</u> Students… • will evaluate and discuss the approximation characteristics of the numerical methods using examples. <u>Competencies</u> Students… • learn how to work with digital structural models and can apply them. • are able to carry out and check computer-aided modeling of structures on the basis of practical construction projects with commercial FE programs and to check them.
Content	• Application of commercial software for modeling of beam structures • static calculation and design

	• discussion of the approximation characteristics of numerical methods using examples • analytical rollover and comparison calculations • control options • Structural analysis-BIM interfaces
Media	-
Literature	

Lectures / Examinations

Title	**ECTS**	**Workload**		**Duration of Exam (min)**
		Lecture h (SWS)	**Self-Study (h)**	
Examination: FE Application in the Construction Practice Part I	3		90	See above
Practical Session: FE Application in the Construction Practice Part I		2	67,5	

Teaching Unit / Examinations: Examination FE Application in the Construction Practice Part I

Title	FE Application in the Construction Practice Part I
Sub-title	FE ACP Part I
Semester	2
Connection to the curriculum	Elective Module

Module: Design Process of Building Construction Part II

Module	Design Process of Building Construction Part II
Module ID	
Module level	Master
Subtitle	DPBCII
Semester	3
Person in charge	Prof. Dr. Sabine Brück-Dürkop
Lecturer	Prof. Dr. Sabine Brück-Dürkop
Language	English
Assignment to the curriculum	Elective
Recommended requirements	none
Participation requirements (study program specific)	none
Teaching Form	Examination, independent project work
Examination mode	Presentation (Referat, 100% graded)
Workload	Total 150h, Practical Work 22,5h, Self-Study 127,5h
ECTS-Credit Points (CP)	5

Learning objectives	<u>Knowledge / Understanding</u>
	Students…
	• Complex projects require specific, success-oriented solution strategies. The design project is based on specific sustainable requirements from planning practice. Iterative procedures are practiced and here the interplay between the planning of its detailing with the special consideration of sustainability.
	• In addition, the following skills and abilities are taught:
	  ○ scientific working methods,
	  ○ Application possibilities of the most diverse, construction and planning-relevant scientific fields,
	  ○ to consider, control and integrate the services of others involved in the planning,
	  ○ Reconciling divergent factors, applying knowledge and integrating it holistically in creating a design solution.…

Content	The way the project work is carried out, i.e. the individual supervision, the discussion in groups at regular colloquia and the final public presentation

	promote the key competencies of the candidates, i.e. their ability to act independently, communicate and interact. Contents. In-depth courses that change every semester with a specific focus on key sustainability issues. A 2-semester project (module 1+module 2) with completion at the end of module 2. Its central object is to integrate sustainability aspects into a given building design draft. It contains synthetic-analytical and scientific components and questions that also contain innovation and research potential. The two-semester duration allows a comprehensive and at the same time intensive course of study, which enables the well-founded development of one's own specializations.
Media	-
Literature	

Lectures / Examinations

Title	**ECTS**	**Workload**		**Duration of Exam (min)**
		Lecture h (SWS)	**Self-Study (h)**	
Examination: Design Process of Building Construction Part II	5		150	See above
Practical Session: Design Process of Building Construction Part II		2	127,5	

Teaching Unit / Examinations: Examination Design Process of Building Construction Part II

Title	Design Process of Building Construction Part II
Sub-title	DPBC Part II
Semester	3
Connection to the curriculum	Elective Module

Module: FE Application in the Construction Practice II

Module	FE Application in the Construction Practice Part II
Module ID	
Module level	Master
Subtitle	FEACPII
Semester	3
Person in charge	Prof. Dr. Sven Klinkel
Lecturer	N.N.
Language	English
Assignment to the curriculum	Elective
Recommended requirements	none
Participation requirements (study program specific)	FE Application in the Construction Process Part I
Teaching Form	Examination, independent project work
Examination mode	Presentation and oral examination (100% graded)
Workload	Total 150h, Practical Work 22,5h, Self-Study 127,5h
ECTS-Credit Points (CP)	5
Learning objectives	<u>Knowledge / Understanding</u> Students… • apply commercial software for modeling of beam, plate and shell constructions. • perform static analysis and dimensioning of real-world examples. <u>Abilities / Skills</u> Students… • will evaluate and discuss the approximation characteristics of the numerical methods using examples. <u>Competencies</u> Students… • learn how to work with digital structural models and can apply them. • are able to carry out and check computer-aided modeling of structures on the basis of practical construction projects with commercial FE programs and to check them.
Content	• Application of commercial software for modeling of beam, plate and shell structures

	• static and dynamic calculation and design • discussion of the approximation characteristics of numerical methods using examples • analytical rollover and comparison calculations • control options • Structural analysis-BIM interfaces
Media	-
Literature	

Lectures / Examinations

Title	**ECTS**	**Workload**		**Duration of Exam (min)**
		Lecture h (SWS)	**Self-Study (h)**	
Examination: FE Application in the Construction Practice Part II	5			See above
Practical Session: FE Application in the Construction Practice Part II		2	127,5	

Teaching Unit / Examinations: Examination FE Application in the Construction Practice Part II

Title	FE Application in the Construction Practice Part II
Sub-title	FE ACP Part II
Semester	3
Connection to the curriculum	Elective Module

Language Courses
Module: Language Course I

Module	Language Course I
Module-ID	
Module level	Master
Subtitle	LC 1
Lecture	See list of lectures and examinations of the module
Semester allocation	2
Person in charge	RWTH Aachen University Language Center
Lecturer	-
Language	German (if not proficient/native speaker)
Assignment to the curriculum	Compulsory Module
Recommended requirements	-None-
Participation requirements (study program specific)	-None-
Teaching form	Written examination, Lecture, Exercise
Examination mode	100% written examination in reading, listening, writing and grammar
Workload	Total 60 h, Lecture hours 23 h (2 SWS), Self-study 37 h
Lecture hours	23 h (2 SWS)
ECTS-Credit Points (CP)	2
Learning Objectives	Students shall learn the basics of the respective language or deepen and expand already existing skills for active participation in everyday and working life.
Content	The course is aimed at students who are looking for a university-specific foreign language education, who need a foreign language for their studies and/or are planning a stay abroad (study, internship, project). Depending on the level, the range of foreign languages on offer considers the training of language skills specific to the profession. In the course you will learn the essential elements of grammar and vocabulary of the respective language, depending on your level, so that you can assert yourself both in writing and orally in everyday communication situations. In addition, you will learn to extract the essential information from

	authentic and university-specific reading and listening texts as well as from various types of texts such as: Write e-mails, letters, messages, and notes.

Lectures / Examinations

Title	ECTS	Workload		Duration of Exam (min)
		Lecture h. (SWS)	Self-Study (h)	
Examination: Language Course I	2	0	0	See examination options
Lecture: Language Course I	0	1	33,5	0
Exercise: Language Course I	0	1	33,5	0

Teaching Unit / Examinations: Examination Language Course I

Title	Examination Language Course I
Sub-title	Exa LC I
Semester allocation	2
Connection to the curriculum	Compulsory Module

Teaching Unit / Examinations: Lecture Language Course I

Title	Lecture Language Course I
Sub-title	L LC I
Semester allocation	2
Connection to the curriculum	Compulsory Module

Teaching Unit / Examinations: Exercise Language Course I

Title	Exercise Language Course I
Sub-title	E LC I
Semester allocation	2
Connection to the curriculum	Compulsory Module

Module: Language Course II

Module	Language Course II
Module-ID	
Module level	Master
Subtitle	LC 2
Lecture	See list of lectures and examinations of the module
Semester allocation	3
Person in charge	RWTH Aachen University Language Center
Lecturer	-
Language	German (if not proficient/native speaker)
Assignment to the curriculum	Compulsory Module
Recommended requirements	-None-
Participation requirements (study program specific)	-None-
Teaching form	Written examination, Lecture, Exercise
Examination mode	100% written examination in reading, listening, writing and grammar
Workload	Total 60 h, Lecture hours 23 h (2 SWS), Self-study 37 h
Lecture hours	23 h (2 SWS)
ECTS-Credit Points (CP)	2
Learning Objectives	Students shall learn the basics of the respective language or deepen and expand already existing skills for active participation in everyday and working life.
Content	The course is aimed at students who are looking for a university-specific foreign language education, who need a foreign language for their studies and/or are planning a stay abroad (study, internship, project). Depending on the level, the range of foreign languages on offer considers the training of language skills specific to the profession. In the course you will learn the essential elements of grammar and vocabulary of the respective language, depending on your level, so that you can assert yourself both in writing and orally in everyday communication situations. In addition, you will learn to extract the essential information from authentic and university-specific reading and listening texts as well as from various types of texts such as: Write e-mails, letters, messages, and notes.

Lectures / Examinations				
Title	**ECTS**	**Workload**		**Duration of Exam (min)**
		Lecture h. (SWS)	**Self-Study (h)**	
Examination: Language Course II	2	0	0	See examination options
Lecture: Language Course II	0	1	33,5	0
Exercise: Language Course II	0	1	33,5	0

Teaching Unit / Examinations: Language Course II	
Title	Examination Language Course II
Sub-title	Exa LC II
Semester allocation	2
Connection to the curriculum	Compulsory Module

Teaching Unit / Examinations: Language Course II	
Title	Lecture Language Course II
Sub-title	L LC II
Semester allocation	2
Connection to the curriculum	Compulsory Module

Teaching Unit / Examinations: Exercise Language Course II	
Title	Exercise Language Course II
Sub-title	E LC II
Semester allocation	2
Connection to the curriculum	Compulsory Module

Master Thesis
Module: Master Thesis

Module	Master Thesis
Module ID	
Module level	Master
Subtitle	MaTh
Semester	4
Language	English
Assignment to the curriculum	Compulsory Module
Recommended requirements	none
Participation requirements (study program specific)	The topic of the master thesis cannot be assigned until 80 CP have been successfully completed.
Examination mode	Master Thesis (100 %, graded) and Colloquium (not graded)
Workload	6 Months
ECTS-Credit Points (CP)	30
Learning objectives	The students learn the independent approach and processing of academic themes, their documentation and written interpretation within a set deadline. They acquire systematic academic research skills.
Content	Completed academic paper, which shall show that the students are capable of independently processing a problem related to their subject according to academic methods within a set deadline.