Description of the degree program

Transportation Engineering (Master)
PO 9

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Specialisation Aviation

Title	Aircraft Design 2		
Number	2515090	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für Flugzeugbau und Leichtbau
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Ingo Staack
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Recommended requirements	Participation in the module "Entwerfen von Verkehrsflugzeugen I"		
Expected performance/ Type of examination	written exam (150 min) or Term Paper (240 min)		
Course achievement			
Examination language	german		

Contents

- Fuselage design of commercial aircraft
- Aerodynamic wing design (cruise aerodynamics, stall behavior)
- Tailplane design (controllability limits, stability limits)
- Engine selection and arrangements
- Overall polar of the aircraft for project stage application
- Weight determination (illustrated on the wing)
- Center of gravity determination (loading variation, allocation of wing and fuselage)
- Load assumptions for aircraft (V-n maneuver and V-n gust diagrams)
- Determination of time-varying loads on aircraft components (illustrated on the maneuver: yaw motion of the aircraft due to a rudder actuation)

Objective qualification

Students gain detailed knowledge of the design of aircraft assemblies, which they can apply to modeling and to solving the individual tasks in the multidisciplinary design process. In addition, the module provides an insight into the procedure for determining structural masses and necessary load assumptions, enabling students to complete their knowledge base in the field of methodical design of commercial aircraft.

Literature

- Heinze,W.: Entwerfen von Verkehrsflugzeugen 2 (Skript zur Vorlesung), IFL TU Braunschweig, Braunschweig 2007
- Torenbeek,E.: Synthesis of Subsonic Airplane Design, Delft University Press, Martinus Nijhoff Publishers, Niederlande 1982

- Roskam,J.: Airplane Design, Part 1-8, DARcorporation Design, Analysis and Research Corporation, Kansas, USA 1997
- Raymer,D.P.: Aircraft Design: A Conceptual Approach, AIAA Education Series, American Institute of Aeronautics and Astronautics Washington D.C., USA 1989
- Scientific papers

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Related courses			
Rules for the choice of courses			
Both courses have to be attended.			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
	1,0	Exercise	german

Title	Flight in Disturbed Atmosphere		
Number	2513050	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für Flugführung
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Peter Hecker
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Recommended requirements	Basic knowledge of fluid mechanics, aerodynamics, flight mechanics and thermodynamics is recommended.		
Expected performance/ Type of examination	written exam (120 min) or oral exam (30 min)		
Course achievement			
Examination language	german		

Contents

The module is divided into two parts. In the first part the weather phenomena important for aviation are described:
1) Atmospheric Physics: Physical causes of wind and turbulence models for benthic boundary layer, thunderstorms, thermals, turbulence

In the second part reactions of the aircraft are modeled and the calculation of loads arising explained:
2) Reaction of the airplane: Unsteady Aerodynamics, equations of motion, reaction of the aircraft to gusts and turbulence, calculation of gust loads, reaction in wind shear, gust load reducing systems.

Objective qualification

The students deepen the known basics in the fields of fluid mechanics, aerodynamics, flight mechanics and thermodynamics and apply these to the specific problems of flight in a disturbed atmosphere. The students are able to assess the causes of and reactions to atmospheric disturbances. They can develop their own proposed solutions using simplified descriptions of complex problems through engineering models.

Literature

Bernard Etkin, Dynamics of Atmospheric Flight, Dover Publications, 2005, 581 S., Paper-back, ISBN-13: 9780486445229, ISBN:0486445224

Bernard Etkin, Theory of Atmospheric Flight, John Wiley and Sons, New York, 1972

Frederic M. Hoblit, Gust Loads on Aircraft: Concepts and Applications, AIAA Education Series, 1988, 306 S., ISBN:0-930403-45-2

James Taylor, Manual on Aircraft Loads, AGARDograph 83, Pergamon Press, 1965

Paul van Gool, Rotorcraft Responses to Atmospheric Turbulence, Thesis Technische Universität Delft, 1997, 306 S., ISBN: 90-407-1519-X

W.H.J.J. van Sraveren, Analyses of Aircraft Responses to Atmospheric Turbulence, Thesis Technische Universität Delft, DUP Science, 2003, 306 S., ISBN: 90-407-2453-9 S.K.

Friedlander, Leonard Topper (Editor), Turbulence # Classical Papers on Statistical Theory, Interscience Publishers, Inc., New York, London, 1961

G:K: Batchelor, The Theory of Homogeneous Turbulence, Cambridege University Press, 1959

J. England/H. Ulbricht, Flugmeteorologie, Transpress, 1990, 399 Seiten, ISBN-10: 3344004298 ISBN-13: 978-3344004293

W. Eichenberger, Flugwetterkunde # Handbuch für die Fliegerei, Motorbuch Verlag Stuttgart, 1995, 355 Seiten, ISBN 3-613-01683-4

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Related courses

Rules for the choice of courses

Both courses have to be attended.

Compulsory attendance

Name of the course	SWS	Eventtype	Language
	2,0	Lecture	german
	1,0	Exercise	german

Literature

The module is divided into two parts. In the first part the weather phenomena important for aviation are described:
Atmospheric Physics: Physical causes of wind and turbulence models for benthic boundary layer, thunderstorms, thermals, turbulence

In the second part reactions of the aircraft are modeled and the calculation of loads arising explained:
Reaction of the airplane: Unsteady Aerodynamics, equations of motion, reaction of the aircraft to gusts and turbulence, calculation of gust loads, reaction in wind shear, gust load reducing systems.

Title	Flight Guidance Systems		
Number	2513220	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für Flugführung
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Peter Hecker
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Expected performance/ Type of examination	written exam (120 min) or oral exam (30 min)		
Course achievement			
Examination language	german		

Contents

This module shows the operation of flight control systems and describes systems for typical flight management tasks like haul flight, takeoff and landing. It is shown how to influence the physical measurement principle, the signal processing, display and process each other. The treated in the lecture topics are deepened in exercises with practical examples.

Basic part:
- Methods and principles of flight guidance.
- Required sensors, data processing and filtering (complementary, estimation and observation filter).
- Preparation of the known physical, fluidic and thermodynamic basics.

Application part: Implementation in economically successful equipment and methods within the constraints of the production technology, international standardization and security of the examples
- Air data systems
- Inertial navigation
- Instrument landing systems (ILS, MLS / GLS)

Objective qualification

After successful completion of the module, the students have application-oriented knowledge in the field of flight guidance systems, such as en-route flight, take-off and landing. They are able to recognise the combination of interdisciplinary fundamentals of electrical engineering, physics and engineering science to the specific problems in the design and use of systems for guiding aircraft and to formulate their own proposals for solutions. After completing the module, students will be able to discuss and assess the technologies of current and planned future flight guidance systems. They will be able to discuss and examine the social, political and economic boundary conditions in the introduction of new systems.

Literature

Fundamentals of Kalman Filtering: A Practical Approach; Paul Zarchan, Howard Musoff; Progress in Astronautics and Aeronautics, Vol. 208; American Institute of Aeronautics and Astronautics, Inc.; Virginia 2005

Guidance and Control of Aerospace Vehicles; Cornelius T. Leondes; University of California Engeneering and ASciences Extension Series; McCraw-Hill Book Company, Inc.; New York, San Francisco, Toronto, London; 1963

Strapdown Inertial Navigation Technology; D.H. Titterton, J.L. Weston; The Institution of Electrical Engineers; Stevenage 2004

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Related courses			
Rules for the choice of courses			
Both courses have to be attended.			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
	1,0	Exercise	german

Title	Aeroplane Performances		
Number	2514500	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät für Maschinen-bau
Module duration	1	**Institution**	Institut für Flugführung
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Peter Hecker
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Recommended requirements	Knowledge of technical mechanics, fluid mechanics, differential and integral calculus, basic understanding of physical relationships		
Expected performance/ Type of examination	written exam (120 min) or oral exam (30 min)		
Course achievement			
Examination language	german		

Contents

The course covers the flight performances of aircraft. The typical approach is to treat the aircraft as a mass point and to investigate the steady and unsteady motion of this point by only using the force equations. Initially, the composition and physics of atmosphere will be provided, followed by fundamental equations (equilibrium of forces) of flight mechanics. After describing the forces, which have an effect on the aircraft such as weight, drag and lift forces and thrust, the performances of level, gliding and turning flights will be mathematically described.

Objective qualification

The students will acquire knowledge about the fundamental mathematical and physical laws which are required for investigations of the flight performance of aircraft under different flight conditions. They will learn to evaluate different types of aircraft based on their performance. They will receive an insight into different factors influencing the flight performance.

Literature

Brüning, G., Hafer, X, Sachs, G., Flugleistungen. Springer-Verlag, 3. Auflage, 1993.

Rosenberg, R. E., Flugleistungserprobung von Strahlflugzeugen, Springer-Verlag, 1987

Hafer, X., Sachs, G., Senkrechtstarttechnik - Flugmechanik, Aerodynamik, Antriebssysteme, Springer-Verlag, 1982.

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
	1,0	Exercise	german

Title	Flight Simulation and Criteria for Handling Qualities		
Number	2514110	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für Flugführung
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Peter Hecker
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Recommended requirements	Knowledge of differential and integral calculus, system dynamics, control engineering, flight mechanics, flight control, basic knowledge of Matlab/Simulink		
Expected performance/ Type of examination	oral exam (45 min)		
Course achievement			
Examination language	german		

Contents

The course contains a deep investigation of the aircraft as a dynamic system and its handling qualities. The focus is on understanding the dynamic interaction between pilot and aircraft. The methods for modelling and simulation as well as the analysis of dynamic systems are presented in an application-oriented manner. The effective application of the software tool Matlab/Simulink is practiced. The utilization of the system dynamics mindset with respect to flight mechanics leads to the most important handling qualities criteria for longitudinal and lateral motion. Numeric criteria and special flight test techniques are discussed. The technologies of today#s flight simulators with respect to flight safety and cost efficiency are presented. In this context the term simulation fidelity is considered focusing on the cognitive capabilities of humans (human centered approach). Finally a spin-off into the area of road vehicle and rotary wing handling qualities is discussed.

Objective qualification

After completing the module, students have the tools to work independently on future tasks in the field of flight system dynamics and acquire an aptitude for analysis for dynamic systems. They can transfer their knowledge to other disciplines - possible spin-offs into the fields of helicopter flight characteristics or the driving characteristics of passenger cars. Graduates will be qualified to take up a scientific position in diverse areas of system dynamics.

Literature

Brockhaus, R.: Flugregelung. Springer Verlag, Berlin, 2001.

Jategaonkar, R.: Flight Vehicle System Identification - A Time Domain Methodology, AIAA, 2006.

Stevens, B.L., Lewis, F.L.: Aircraft Control and Simulation, John Wiley & Sons, Inc. 2003.

NN: Flying Qualities of Piloted Aircraft, US Department of Defense, MIL-HDBK-1797, 1997.

Padfield, G. D.: Helicopter Flight Dynamics, Second Edition, Blackwell Publishing, 2007.

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
	1,0	Exercise	german

Title	Air Traffic Management (ATM) - Advanced Applications		
Number	2513080	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für Flugführung
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Peter Hecker
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Recommended requirements	No specific requirements are recommended.		
Expected performance/ Type of examination	1 examination element: oral exam (30 min) or written exam (120 min)		
Course achievement			
Examination language	german		

Contents

The module describes the basic functions of air traffic management (ATM) and their application in practice:

- Fundamentals of Air Traffic Management (ATM) / Air Traffic Service / Traffic Flow Management / Airspace management / Network Manager (formerly CFMU)
- Harmonization of airspace: Single European Sky (SES) / Performance Scheme /Functional Airspace Blocks (FAB) / SESAR / NEXTGEN
- Punctuality, Increasing airport capacity: airport collaborative decision making (A-CDM)
- Capacity planning processes / flexible use of airspace (FUA)
- Increasing capacity in the airspace: reduction of lateral and vertical separation (RVSM)
- Traffic flow management (ATFM)/ reduction of airspace delays: Network Manager / Command and Control Center (FAA - USA): ATFM in USA (FAA)
- Navigation strategy / Performance Based navigation (PBN/RNAV/RNP): operational comparison of SBAS/GBAS/ILS
- Obstacle Clearance / Airports, flight calibration of navigation systems
- Slot planning: strategic / tactical / operational slot planning (approach and departure / AMAN / DMAN)
- Modern surveillance systems (multilateration MLAT/PAM/WAM, ADS-B/C/R/AOS)
- Outlook on future ATM concepts/ new CNS systems/ automation approaches / New operational concepts: Continuous descent operations (CDO) / Point-Merge-Procedures / sector-less control / remote tower operations (RTO) / parallel runway operations (dependent / independent / RPAT approaches)
- (Safety / Security): Examples from practice based on "near misses" and "accidents": separation infringements ("Loss of Separation") / near misses / aircraft accidents
- Application of procedures and systems for conflict detection and resolution: ACAS / TCAS / STCA / MTCD,/Examples: mid-air collision Ueberlingen, runway incursion Mailand-Linate
- Integration of Unmanned Aerial Vehicle into the airspace system (UAS / UAV / RPAS / UAM / UTM)

Objective qualification

Students will be able to understand and subsequently investigate the flow of traffic in airspace and at commercial airports. They will be able to make judgments about air traffic control process chains based on case

studies. Students will be able to recognize the emergence of potential conflicts in air traffic and to independently develop and evaluate potential solutions.

Literature

1. Moderne Flugsicherung: Organisation, Verfahren, Technik; H. Mensen; 3., neu bearbeitete Auflage; Springer-Verlag; Berlin Heidelberg; 2004
2. European Air Traffic Management - Principles, Practice and Research; A. Cook; University of Westminster, UK; Ashgate Publishing Limited; Aldershot, UK; 2007
3. Fundamentals of Air Traffic Control; M. Nolan; 4th ed; Brooks Cole; 2003
4. Single European Sky: Report of the High-Level Group; European Commission; 2001

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Related courses

Rules for the choice of courses

Both courses have to be attended

Compulsory attendance

Name of the course	SWS	Eventtype	Language
	2,0	Lecture	german
	1,0	Exercise	german

Title	Satellite Navigation - Technologies and Applications		
Number	2513060	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für Flugführung
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Peter Hecker
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Expected performance/ Type of examination	1 Examination element: written exam (120 min) or oral exam (30 min)		
Course achievement			
Examination language	german		

Contents

This Modul imparts a detailed insight into technology, methods and applications of global navigation satellite systems (GNSS) for navigation in general and in special for aviation and telematics. After preparing necessary basics in the field of radio navigation and orbit mechanics, the system concept of satellite navigation is introduced. This also includes the basic principles for the determination of position, velocity and time using satellite navigation. Within this, the used measurements and their corresponding errors are characterized. Based on modern satellite navigation receivers the practical use of satellite navigation for different applications is presented, detailing standalone GNSS positioning as well as integrated systems with complimentary sensors (e.g. GNSS and inertial navigation). Special emphasis is placed on the use of satellite navigation for aviation applications. This includes all phases of flight (departure, en-route, approach, landing and taxi) using different techniques.

Objective qualification

After successful completion of the module, the students have theoretical as well as application-oriented knowledge in the field of satellite navigation. The students are then able to independently carry out position solutions on the basis of real measurement data as well as to analyse and independently solve specific problems in the use of satellite navigation, also in combination with complementary navigation sensors, in various areas of application in aviation or land applications. After completing the module, the students can discuss and assess the technologies of current and planned future flight guidance systems. They can discuss and examine the social, political and economic boundary conditions in the introduction of new systems.

Literature

- Parkinson, B., Spilker, J., et al., Global Positioning System # Theory and Applications, Volumes I+II, AIAA, 1996
- Mansfeld, W, Satellitenortung und Navigation # Grundlagen und Anwendung globaler Satellitennavigationssysteme Seeber, Günter: Satellitengeodesie, 2. Auflage / Satellite Geodesy 2nd Edition, de Gruyter, 2003
- Hofmann-Wellenhof, B. et al., Navigation # Principles of Positioning and Guidance, Springer, 2003
- Hofmann-Wellenhof, B. et al., GPS # Theory and Practice, 5th Edition, Springer, 2001
- Teunissen, P.J.G., Kleusberg, A. (Hrsg.), GPS for Geodesy, 2nd Edition, Springer, 1998
- Farell, Jay A., Barth, Matthew, The Global Positioning System & Inertial Navigation

- Misra, P., Enge, P., Global Positioning System # Signals, Measurements and Performance
- Schrödter, Frank, GPS Satelliten-Navigation, Franzis#, 1994
- Bauer, Manfred: Vermessung und Ortung mit Satelliten, 5. neu bearbeitete und erweiterte Auflage, Wichmann, 2003
- Prasad, R., Ruggieri, M., Applied Satellite Navigation # Using GPS, GALILEO, and Augmentation Systems

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Related courses			
Rules for the choice of courses			
Both courses have to be attended.			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
	1,0	Exercise	german

Title	Safety and Certification in Aviation		
Number	2513310	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	Fakultät für Maschinen-bau
Module duration	1	**Institution**	Institut für Flugführung
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Peter Hecker
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Recommended requirements	Basic knowledge of flight guidance		
Expected performance/ Type of examination	1 Examination element: written exam, 90 minutes or oral exam, 30 minutes		
Course achievement			
Examination language	german		

Contents

This module covers the history of the aircraft certification as well as international certification regulations and procedures. Occurrence reporting and aviation accident investigation are considered as the foundation of the continuing airworthiness of certified aircraft. The tasks and responsibilites of aviation authorities and organisations are described, as well as the approval of Design Organisations and the procedures and privileges thereof. Additionally, the optimization of certification and oversight concepts for enhanced aviation safety are presented. Finally, continuing airworthiness modelling and health monitoring concepts for more effective aviation accident prevention and the future of the air transportation system are given.

Objective qualification

On completion of this module, students will be able to list, reproduce and discuss the procedures involved in aviation regulation and certification. The students are able to discuss the proof of compliance with certification regulations through tests, analyses or simulation. They understand the role of air transport in the field of tension between politics, economy and ecology and can explain their influencing factors.

Literature

http://www.easa.europa.eu/ ?#61472? http://www.icao.int/Pages/default.aspx
http://www.faa.gov/
http://www.jaa.nl/introduction/introduction.html
http://www.lba.de/DE/Home/home_node.html
Cologne Compendium on Air Law in Europe ISBN13: 9783452275233, ISBN: 345227523X, März 2013, Carl Heymanns Verlag KG (Co-Autor)
http://www.bazl.admin.ch/dokumentation/grundlagen/02643/

Remark

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Related courses			
Rules for the choice of courses			
Both courses have to be attended			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	3,0	Lecture/Exercise	german

Specialisation Automotive Engineering

Title	Advanced Driver Assistance Systems		
Number	2534000000	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the summer term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für Fahrzeugtechnik
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Roman Henze
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Expected performance/ Type of examination	1 examination element: written exam (90 min) or oral exam (30 min)		
Course achievement			
Examination language	english		

Contents

- Motivators for the development of advanced driver assistance systems
- Definition and categorization of systems
- Functionality, performance and areas of application of various sensors
- Concepts for satellite positioning and Car2X communication
- Comparison of relevant driver assistance systems: Field of application, sensor technology, functionality, state of research
- Test procedures, simulation tools and test equipment
- Relevant standards in vehicle engineering: Functional safety and SOTIF
- Introduction to legislation, liability law and differentiation from automated driving

Objective qualification

Students are able to categorize advanced driver assistance systems (ADAS) in the levels of automation and differentiate them from passive safety systems.
Based on the requirements of an assistance system, students will be able to assess an existing sensor concept and discuss the use of additional sensors to record and interpret the driving environment, the vehicle and the driver. Students will be able to analyze the functionality of series-close and research-relevant driver assistance systems in the context of their field of application and categorize them on the basis of various criteria. Students are able to understand network architectures in the vehicle and categorize communication technologies according to system requirements.
Given development objectives, students are able to select suitable test procedures (e.g. simulative, hardware-in-the-loop, real tests) and develop a test plan.
Students will be able to carry out a risk assessment of a technical system in accordance with relevant standards in the automotive industry (in particular functional safety) and derive requirements for safety assessment. Students are able to name the legal framework conditions for the introduction of ADAS and demonstrate the transferability to the approval of higher automation systems.

Literature

- Gasser, T. M.; Seeck, A.; Smith, B. W.: Rahmenbedingungen für die Fahrerassistenzentwicklung, in Handbuch Fahrerassistenzsysteme: Grundlagen, Komponenten und Systeme für aktive Sicherheit und Komfort, Winner, H.; Hakuli, S.; Lotz, F.; Singer, C. Eds.: Springer Vieweg Wiesbaden, 2015, pp. 27–54.
- Haas, R.E.; Bhattacharjee, S.; Möller, D.P.F.: Advanced Driver Assistance Systems. In: Akhilesh, K.; Möller, D. (eds) Smart Technologies. Springer, Singapore, 2020. https://doi.org/10.1007/978-981-13-7139-4_27
- ISO 26262: Road vehicles - Functional safety, International Organization for Standardization, 2018.
- ISO/SAE PAS 22736: Taxonomy and definitions for terms related to driving automation systems for on-road motor vehicles, International Organization for Standardization, 2021.
- Joseph, L.; Mondal, A. K.: Autonomous Driving and Advanced Driver-Assistance Systems (ADAS): Applications, Development, Legal Issues, and Testing, 2021. Doi: 10.1201/9781003048381.
- Küçükay, F.: Grundlagen der Fahrzeugtechnik: Antriebe, Getriebe, Energieverbrauch, Bremsen, Fahrdynamik, Fahrkomfort. Springer Fachmedien Wiesbaden, 2022.
- Li, Y.; Shi, H.: Advanced Driver Assistance Systems and Autonomous Vehicles: Springer, 2022. [Online]. Available: https://link.springer.com/content/pdf/10.1007/978-981-19-5053-7.pdf
- Liesner, L.: Automatisierte Funktionsoptimierung von Adaptive Cruise Control, Dissertation, Technische Universität Braunschweig; Shaker Verlag.
- Seiniger, P.; Weitzel, A.: Testverfahren für Verbraucherschutz und Gesetzgebung, in Handbuch Fahrerassistenzsysteme: Grundlagen, Komponenten und Systeme für aktive Sicherheit und Komfort, Winner, H.; Hakuli, S.; Lotz, F.; Singer, C. Eds.: Springer Vieweg Wiesbaden, 2015, pp. 167–182.
- Pawellek, T.; Liesner, L.; Henze, R. and Küçükay, F.: Objektivierungsverfahren für eine kundenoptimale ACC-Systemauslegung, ATZ Automobiltechnische Zeitschrift, vol. 118, no. 4, pp. 74–79, 2016, doi: 10.1007/s35148-016-0020-6.
- Waschl, H.; Kolmanovsky, I.; Willems, F. Eds.: Control strategies for advanced driver assistance systems and autonomous driving functions: Development, testing and verification. Cham, Switzerland: Springer, 2019.

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Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language
Advanced Driver Assistance Systems	2,0	Lecture	english
Advanced Driver Assistance Systems	1,0	Exercise	english

Title	Alternative, electro and hybrid drives		
Number	2534060	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für Fahrzeugtechnik
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Roman Henze
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Expected performance/ Type of examination	1 Examination element: written exam (90 min)		
Course achievement			
Examination language	german		

Contents

- Historical overview of alternative powertrains
- Legal and political frameworks for powertrain development
- Primary energy sources and fuels
- Hybrid and electric drivetrains
- Components of hybrid and electric drivetrains
- Fuel cell electric vehicles
- Comparison of drivetrain concepts
- Outlook towards future powertrain development trends

Objective qualification

After completion of the module, students are able to evaluate alternative drive concepts as well as their design and conception. Students are able to discuss the historical, legal, economic and ecological boundary conditions for alternative, electric and hybrid drives on the basis of a comprehensive foundation. The students are able to assess different measures for improving efficiency and thus reducing fuel consumption on the basis of the elements of energy consumption as well as their knowledge about the influences of powertrain and vehicle parameters. The students can enumerate exemplary field conditions for the use of alternative and electrified vehicles and derive the resulting requirements for the powertrain. The students are independently able to classify electric and hybrid vehicles and their components with regard to their structure and functions, to integrate them into new vehicle concepts and to compare them on the basis of efficiency, performance, cost and installation space criteria. In addition, the students will be able to describe the transmissions integrated in HEV and BEV, their specifics and requirements as well as the requirements for chassis and brakes in vehicles with electrified drives using examples. Furthermore, the students are able to classify and evaluate electric motors, power electronics, energy sources and storage systems based on appropriate criteria.

Literature

- TSCHÖKE, H.: Die Elektrifizierung des Antriebsstrangs -Grundlagen -vom Mikro-Hybrid zum vollelektrischen Antrieb, Springer Verlag, 2019

- NAUNHEIMER, H.: Fahrzeuggetriebe #Grundlagen, Auswahl, Auslegung und Konstruktion, Springer Verlag, 2019
- HOFMANN, P.: Hybridfahrzeuge, Springer Verlag, 2014
- KAMPKER, A.: Elektromobilität, Springer Verlag, 2018
- KREMSER, A.: Elektrische Maschinen und Antriebe #Grundlagen, Motoren und Anwendungen, Springer Verlag, 2017
- KLELL, M.: Wasserstoff in der Fahrzeugtechnik #Erzeugung, Speicherung, Anwendung, Springer Verlag, 2018
- REIF, K.: Basiswissen Hybridantriebe und alternative Kraftstoffe, Springer Verlag, 2018
- AVL: Engine and Environment, Proceedings, AVL, 2018
- ZACH, F.: Leistungselektronik, Springer Verlag Wien, 2010
- GEHRINGER, B.: 39. Internationales Wiener Motorensymposium, Proceedings, VDI Fortschritt-Berichte, 2018
- BINDER, A.: Elektrische Maschinen und Antriebe #Grundlagen, Betriebsverhalten, Springer Verlag, 2017
- NELSON, V.: IntroductiontoRenewableEnergy, CRC Press, 2015
- DENTON, T.: ElectricandHybrid Vehicles, CRC Press, 2016
- STAN, C.: Alternative Antriebe für Automobile: Hybridsysteme, Brennstoffzellen, alternative Energieträger, Springer Verlag, 2012
- VOGEL, M.: Kompendium Li-Ionen Batterien. Grundlagen, Bewertungskriterien, Gesetze und Normen, VDE Verband der Elektrotechnik, 2015
- LIEBL, J.: Energiemanagement im Kraftfahrzeug, Springer Verlag, 2014 ITS
- NIDERSACHSEN: Hybrid and ElectricVehicles, Proceedings, ITS, 2018
- BABIEL, G.: Bordnetze und Powermanagement, Springer Verlag, 2019

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
Alternative, Electro and Hybrid Drives	2,0	Lecture	german
	1,0	Exercise	german

Title	Automated Road Vehicles: from Assistance to Autonomy		
Number	2412620	**Module version**	
Shorttext		**Language**	
Frequency of offer	only in the summer term	**Teaching unit**	Fakultät für Elektrotechnik, Informationstechnik, Physik
Module duration	1	**Institution**	
Hours per Week / ECTS	4 / 5,0	**Module owner**	Prof. Dr. Markus Maurer
Workload (h)	150		
Class attendance (h)	56	**Self studying (h)**	94
Compulsory requirements			
Expected performance/ Type of examination	Written exam (60 min) or oral exam (30 min)		
Course achievement			
Examination language			

Contents

-probabilistic knowledge representation for driver assistance and vehicle guidance systems
- radar-based and visual machine perception
- machine situation detection and behavioural decision-making
- human-machine-interaction
- design and test of driver assistance and vehicle guidance systems

Objective qualification

After completing this module, students will have basic knowledge of driver assistance systems and automated vehicles. They are familiar with the current state of the art in driver assistance systems and automated driving functions and know about the function-determining factors. The students are able to independently plan customer-value driver assistance systems and systems for vehicle automation.

Literature

- Handbook of Driver Assistance Systems;
Basic Information, Components and Systems for Active Safety and Comfort; Editors: Winner, H., Hakuli, S., Lotz, F.,
Singer, C. (eds.); 1. Edition 2016 Springer;
available free of charge for students via Springer-Link

Remark

The course “Automotive Systems Engineering” provides helpful background knowledge for this course; however, it is not a mandatory prerequisite for participation.

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Related courses			
Rules for the choice of courses			
Only one of the three modules ET-IFR-42, ET-IFR-58, ET-IFR-62 can be chosen.			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
Literature			
- Hermann Winner (Hrsg.), Stephan Hakuli (Hrsg.), Gabriele Wolf (Hrsg.): Handbuch Fahrerassistenzsysteme Grundlagen, Komponenten und Systeme für aktive Sicherheit und Komfort, Springer, 3. Auflage 2015, ISBN: 978-3658057336 - R. Bishop. Intelligent Vehicle Technology and Trends, Artech House, Boston, 2005, ISBN: 978-1580539111 - M. Maurer, C. Stiller. Fahrerassistenzsysteme mit maschineller Wahrnehmung, Springer, Heidelberg, 2005, ISBN: 978-3540232964 - S. Thrun, W. Burgard, D. Fox. Probabilistic Robotics			
	2,0	Exercise	german
Literature			
- Hermann Winner (Hrsg.), Stephan Hakuli (Hrsg.), Gabriele Wolf (Hrsg.): Handbuch Fahrerassistenzsysteme Grundlagen, Komponenten und Systeme für aktive Sicherheit und Komfort, Springer, 3. Auflage 2015, ISBN: 978-3658057336 - R. Bishop. Intelligent Vehicle Technology and Trends, Artech House, Boston, 2005, ISBN: 978-1580539111 - M. Maurer, C. Stiller. Fahrerassistenzsysteme mit maschineller Wahrnehmung, Springer, Heidelberg, 2005, ISBN: 978-3540232964 - S. Thrun, W. Burgard, D. Fox. Probabilistic Robotics			

Title	Vehicle Homologation and Integral Safety		
Number	2534000010	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für Fahrzeugtechnik
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Roman Henze
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Expected performance/ Type of examination	2 examination elements: a) Vehicle Homologation: written exam (60 min) or oral exam (30 min) (weighting in the calculation of the overall module grade: 1/2) b) Integral Vehicle Safety: written examination (60 min) or oral examination (30 min) (weighting in the calculation of the overall module grade: 1/2)		
Course achievement			
Examination language	german		

Contents

Vehicle homologation:
- Vehicle homologation in Europe at a glance
- The type approval procedure
- Details on the definitions of vehicle types and the regulations on masses and dimensions
- Virtual test procedures
- Complex electronic systems: Consideration in the current technical vehicle regulations
- Test procedures in accordance with ECE-R 51 # Noise emissions

Integral vehicle safety:
- Active and passive safety
- Assessment criteria
- Test procedures and equipment
- Testing and computerised simulation

Objective qualification

Vehicle homologation:
Students will be able to categorise approval procedures based on type approval guidelines and derive defined vehicle classes. Furthermore, they will be able to determine, sketch and compare the masses and dimensions of individual vehicle classes on the basis of technical vehicle regulations. With the aid of electronic vehicle control systems, students are also able to derive requirements for modern system architectures and assess the technical interactions between the systems relevant to approval. On the basis of environmental and safety-relevant regulations for the approval of motor vehicles, students will be able to describe test components and reproduce relevant test sequences. With the acquired knowledge, students are able to present and apply holistic interrelationships in the homologation process of motor vehicles across all classes.

Integral vehicle safety:
After completing the subject area ‘Integral Vehicle Safety’, students will have a basic knowledge of accident-reducing and accident-preventing measures and will be able to categorise, analyse and evaluate vehicle technology developments accordingly. They know important accident statistics and are able to derive potential fields of action for safety measures. Students are familiar with the concept of biomechanics in the context of vehicle safety as well as investigation methods, load variables and protection criteria and are able to analyse accident events and derive accident consequences on this basis. Students will be able to name and comparatively describe the test regulations according to US FMVSS208 and ECE R94 as well as the GTR for pedestrian protection with regard to test conditions and implementation. They will also be able to verify standard test conditions using rough calculations. Students will also be able to define the pre-crash phase, name important systems and assess the safety potential of Car-to-X communication.

Literature

- GASSER, T. M.; Seeck, A.; Smith, B. W.: Rahmenbedingungen für die Fahrerassistenzentwicklung, in Handbuch Fahrerassistenzsysteme: Grundlagen, Komponenten und Systeme für aktive Sicherheit und Komfort, Winner, H.; Hakuli, S.; Lotz, F.; Singer, C. Eds.: Springer Vieweg Wiesbaden, 2015, pp. 27–54.
- KRAMER, F.: Passive Sicherheit von Kraftfahrzeugen. Grundlagen, Komponenten, Systeme. Wiesbaden: Vieweg+Teubner Verlag, 1998
- ISO 17025, 2018: Allgemeine Anforderungen an die Kompetenz von Prüf- und Kalibrierlaboratorien
- ROBERT BOSCH GMBH: Kraftfahrtechnisches Taschenbuch, 24. Auflage, Vieweg+Teubner Verlag, 2002 Richtlinie 2007/46/EG des Europäischen Parlaments und des Rates vom 5. September 2007 zur Schaffung eines Rahmens für die Genehmigung von Kraftfahrzeugen und Kraftfahrzeuganhängern sowie von Systemen, Bauteilen und selbstständigen technischen Einheiten für diese Fahrzeuge
- SEIFFERT, BRAESS: Handbuch der Kraftfahrzeugtechnik, Vieweg, 2000
- SEIFFERT, U.: Fahrzeugsicherheit Personenwagen, VDI-Verlag, Düsseldorf, 1992
- SEIFFERT, U.: Automotive Safety Handbook, SAE International, 2003
- SEINIGER, P.; WEITZEL, A.: Testverfahren für Verbraucherschutz und Gesetzgebung, in Handbuch Fahrerassistenzsysteme: Grundlagen, Komponenten und Systeme für aktive Sicherheit und Komfort, Winner, H.; Hakuli, S.; Lotz, F.; Singer, C. Eds.: Springer Vieweg Wiesbaden, 2015, pp. 167–182.
- TÜV NORD: Das Typgenehmigungsverfahren für Kraftfahrzeuge, Bonn: Kirschbaum Verlag, 2019

Remark

The course “Vehicle homologation” takes place in the summer semester.
The course “Integral Vehicle Safety” takes place in the winter semester.

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Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language
Vehicle Homologation	1,5	Lecture	german
Integral Safety	1,5	Lecture	german

Title	Mobile Machines and Commercial Vehicles		
Number	2517180	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für mobile Maschinen und Nutzfahrzeuge
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Thomas Vietor
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Recommended requirements	There are no special professional requirements for participation in the course.		
Expected performance/ Type of examination	written exam (90 min) or oral exam (30 min)		
Course achievement			
Examination language	german		

Contents

- principles of vehicles and components
- main features of agricultural engineering
- heavy commercial vehicles
- trailers and semi-trailers
- technology in intralogistics
- use and construction of earth-moving machines
- legal requirements (Machinery Directive)

Objective qualification

After successful completion of this module, students are able to:
- describe different technical designs and typical areas of application of mobile machines, commercial vehicles, buses and industrial trucks.
- categorize the variety of mobile machines at a glance and assign the application areas of the machines.
- calculate, compare and evaluate machine concepts and components through comprehensive knowledge in the areas of structure, process technology, powertrain technology, chassis and wheel-to-ground interaction.
- decide which mobile machine including equipment is suitable based on the requirements and the work task.
- name the basic requirements of the Machinery Directive, its national implementation and the use of harmonized standards in the development of mobile machinery.

Literature

- Braun, H.; Kolb, G.: LKW - Ein Lehrbuch und Nachschlagewerk. Bonn: Kirschbaum Verlag 2012, ISBN 9783781218505.

- Eichhorn, H. (Hrsg.): Landwirtschaftliches Lehrbuch: Landtechnik. Stuttgart: Ulmer 1999, ISBN 3800110865.
- Hoepke, E.; Breuer, S. (Hrsg.): Nutzfahrzeugtechnik: Grundlagen, Systeme, Komponenten. Wiesbaden: Springer Vieweg 2016, ISBN 9783658095376.
- Kunze, G.; Göhring, H.; Jacob, K.; Scheffler, M. (Hrsg.): Baumaschinen: Erdbau- und Tagebaumaschinen, Wiesbaden: Vieweg & Teubner 2012, ISBN: 9783834815927.
- MAN Truck & Bus AG (Hrsg.): Grundlagen der Nutzfahrzeugtechnik, Lkw und Bus. Lehrbuch der MAN Academy. Bonn: Kirschbaum Verlag 2016, ISBN 9783781219946.
- Pischinger, S.; Seiffert, U. (Hrsg.): Vieweg Handbuch Kraftfahrzeugtechnik. Wiesbaden: Springer Vieweg 2016, ISBN 9783658095277.
- Renius, K. T.: Fundamentals of Tractor Design. Cham: Springer Verlag 2020, ISBN 9783030328047.

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
	1,0	Exercise	german

Title	Modelling and Simulation in Automotive Engineering		
Number	2540380	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für Akustik und Dynamik
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Ulrich Römer
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements	none		
Recommended requirements	none		
Expected performance/ Type of examination	1 Examination element: written exam (90 min) or oral exam (30 min)		
Course achievement			
Examination language	german		

Contents

Deriving the equations of motion of vehicle models, drive sections and brakes, steering and tires, simulation using MATLAB, MATLAB techniques towards interpreting the results, Possibilities of coupling physical and experimental models.

Objective qualification

Students can use the complex simulation tool MATLAB for vehicle engineering problems. They independently develop MATLAB functionalities adapted to the problem. They are able to create functions and subfunctions, use different visualization techniques, and develop equations of motion for vehicle models, drive elements and brakes, steering, and tires. In particular, students can apply and evaluate the coupling of physical and experimental models.

Literature

- H.Willumeit, Modelle und Modellierungsverfahren in der Fahrzeugdynamik, B.G.Teubner, 1998
- G.Genta, Motor Vehicle Dynamics, Modeling and Simulation, World Scientific, 1997
- W.Pietruska, MATLAB in der Ingenieurpraxis, B.G.Teubner, 2015

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
	1,0	Exercise	german

Specialisation Transport Planning and Local Public Transport

Title	Local Public Transport - Supply Planning		
Number	4310770	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Verkehr und Stadtbauwesen
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Bernhard Friedrich
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) or oral exam (approx. 30 Min.) (in the Master's programme in Social Sciences as a course achievement)		
Course achievement	Term paper		
Examination language	german		

Contents

Public transport - service planning (VÜ)
- organizational and legal basics of the public transport system
- network planning in the context of settlement development
- public transport systems and their performance capabilities
- overview of circulation, vehicle and personnel planning
- distribution of tickets, the organization in transport associations and tariffing
- financing of public transport,
- marketing strategies in public transport
- differentiated modes of operation in public transport
- acceleration of public transport in urban road networks

Objective qualification

Students will gain knowledge of the interrelationships, systems and laws that must be taken into account when planning public transport services. They will be able to design or further develop and implement public transport services for urban and rural public transport, with the respective boundary conditions and systems to be taken into account. Public transport services are differentiated for road (IVS – Prof. Friedrich) and rail transport (IVE – Prof. Siefer).

Literature

-Differenzierte Bedienung im ÖPNV - Flexible Bedienungsweisen als Baustein eines markorientierten Leistungsangebotes,
-Blaue Buchreihe des VDV, Heft 15, DVV Media Group GmbH, April 2009.
-Stadtbahnsysteme Light Rail Systems. Grundlagen, Technik, Betrieb und Finanzierung. Blaue Buchreiche des VDV,
DVV Media Group GmbH, Juni 2014

-Richtlinien, Hinweise und Merkblätter der Forschungsgesellschaft für Straßen- und Verkehrswesen (www.fgsv-verlag.de).
-Reinhardt, W. Öffentlicher Personennahverkehr. Vieweg + Teubner Verlag. Springer Fachmedien Wiesbaden GmbH,
2012.

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Local Public Transport - Operation and Vehicles		
Number	4398050	**Module version**	
Shorttext		**Language**	english german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Planung des öffentlichen Verkehrs
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Thomas Siefer
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) or oral exam (approx. 30 Min.) (in the Master's programme in Social Sciences as a course achievement)		
Course achievement			
Examination language	english german		

Contents

[Public Transport - Operation and Vehicles (V/Ü)]
Introduction:
-demand
-Transport associations and transport communities

Operation
-Operational planning
-Operations management
-Operations supervision
-organisation, management, personnel, (+telematics)

vehicles:
-Building and maintenance of vehicles
-Energy supply; alternative drives
-Operational safety and automation
-circulation and vehicle dispatching/deployment

distribution:
-tariffing
-Types of ticket sales
-Free public transport

Quality management / connection planning:
-Awarding of bus and rail services
-control
New systems, multimodality, mobility development

Objective qualification

The students gain knowledge about the operational management of public transport, with a focus on the deployment planning of personnel and vehicles. In the area of vehicles, it is shown how vehicles are procured and used according to demand. The students are able to evaluate the special features of different vehicle concepts (e.g. high-floor and low-floor) depending on the areas of application. Furthermore, the students acquire basic knowledge about construction, maintenance and drive technologies of vehicles. The basics of energy supply are taught. In the area of operation, students are to ensure continuous transport chains in urban traffic.
Literature
Reinhardt: Öffentlicher Personennahverkehr
Remark

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Local Public Transport - Planning and Infrastructure		
Number	4398060	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Planung des öffentlichen Verkehrs
Hours per Week / ECTS	4 / 6,0	**Module owner**	Alejandro Tirachini Hernández
Workload (h)	₁₈₀		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) or oral exam (approx. 30 Min.)		
Course achievement			
Examination language	german		

Contents

[Public Transport - Infrastructure Planning (V/Ü)]
- Definition of lane-guided systems in urban transport
- Development of light rail systems
- Planning approaches/ responsibilities
- Legal basis
- Financing
- Planning approval and project sequence
- System design
- Planning principles for alignment and routes
- Construction and maintenance of infrastructure
- stations
- Energy supply (trackside)
- Current developments in Germany and worldwide
- Overview of safety systems for railways in urban traffic
- Train protection
- Route protection
- Train control and driverless operation
- Route protection in areas with road traffic participation

Objective qualification

The students are able to plan infrastructure facilities for public transport (rail and road) in Germany according to the relevant procedures and rules for a specific application and to accompany the construction. The knowledge of these basics is necessary for economic and ecological operation. As employees of a local transport operator or a planning office for a planned application, they are able to select suitable safety systems and dimension them operationally. They are able, under the guidance of experienced planning engineers in the planning of safety equipment.

Literature
• Reinhardt: Öffentlicher Personennahverkehr • Pachl: Systemtechnik des Schienenverkehrs • Naumann: Leit- und Sicherungstechnik im Bahnbetrieb

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title			
Number	3329000000	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration		**Institution**	Institut für Planung des öffentlichen Verkehrs
Hours per Week / ECTS	4 / 6,0	**Module owner**	Alejandro Tirachini Hernández
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Exam (120 Min.)		
Course achievement			
Examination language	english		

Contents

- Motivation: why public transport and history of public transport

- Public transport planning: strategic, tactical and operational decisions

- User costs and values of time in public transport

- Single line design: Determination of frequency of service, type of vehicle

- Single line design: stop/station design and density

- Network design: general rules, simple models, complex models

- Waiting time modelling and timetabling

- Pricing and financing

- Public transport ownership and regulation

- Demand modelling, quality of service and user satisfaction

- Future public transport

Objective qualification

The students acquire an in-depth understanding of planning processes in public transport systems. Upon successful completion, students will be able to: (1) apply methods for designing single public transport lines (including route alignment, stop location, frequency, and vehicle size determination), considering the concepts of value of time, user cost components (access, waiting, in-vehicle time, transfers), and operator cost, informed by empirical data; (2) formulate and solve fundamental frequency setting and optimal stop spacing problems; (3) evaluate public transport network structures based on density principles and solve basic network design problems under constraints; (4) analyse public transport timetabling problems using different objective functions; (5) critically assess fare systems and pricing principles using welfare economics and practical fare setting rules; (6) compare models of public transport organization and ownership including

regulation; (7) utilize fundamental concepts of public transport demand modelling including mode choice, and (8) discuss topics pertaining to future developments such as automation and sustainability challenges in the public transport industry.
Literature
Präsentation, Artikel, Buchkapitel

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title			
Number	3329000000	**Module version**	V1
Shorttext		**Language**	english
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration		**Institution**	Institut für Planung des öffentlichen Verkehrs
Hours per Week / ECTS	4 / 6,0	**Module owner**	Alejandro Tirachini Hernández
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Exam (120 Min.)		
Course achievement			
Examination language	english		

Contents

- Motivation: why public transport and history of public transport

- Public transport planning: strategic, tactical and operational decisions

- User costs and values of time in public transport

- Single line design: Determination of frequency of service, type of vehicle

- Single line design: stop/station design and density

- Network design: general rules, simple models, complex models

- Waiting time modelling and timetabling

- Pricing and financing

- Public transport ownership and regulation

- Demand modelling, quality of service and user satisfaction

- Future public transport

Objective qualification

The students acquire an in-depth understanding of planning processes in public transport systems. Upon successful completion, students will be able to: (1) apply methods for designing single public transport lines (including route alignment, stop location, frequency, and vehicle size determination), considering the concepts of value of time, user cost components (access, waiting, in-vehicle time, transfers), and operator cost, informed by empirical data; (2) formulate and solve fundamental frequency setting and optimal stop spacing problems; (3) evaluate public transport network structures based on density principles and solve basic network design problems under constraints; (4) analyse public transport timetabling problems using different objective functions; (5) critically assess fare systems and pricing principles using welfare economics and practical fare setting rules; (6) compare models of public transport organization and ownership including

regulation; (7) utilize fundamental concepts of public transport demand modelling including mode choice, and (8) discuss topics pertaining to future developments such as automation and sustainability challenges in the public transport industry.
Literature
Präsentation, Artikel, Buchkapitel

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Transport Planning		
Number	4318020	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Verkehr und Stadtbauwesen
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Bernhard Friedrich
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) or oral exam (30 Min.)		
Course achievement	Homework assignment		
Examination language	german		

Contents

[Verkehrsplanung (VÜ)]
- Introduction to transport planning
- Planning Methodology
- Behavioural traffic surveys
- Planning of transport networks
- Planning of measures in public transport (external lecturer from the field)
- Decision models
- Traffic models (traffic generation, traffic distribution, traffic allocation)
- Impact models and evaluation procedures
- Traffic safety

Objective qualification

The students gain an overview of the characteristics of mobility, the socio-economic significance of transport that can be derived from this and the resulting legal anchoring of spatial and transport planning. Based on the understanding of the problems and tasks of transport planning, the planning methodology and the instruments of transport network planning in public transport and individual transport are introduced. In this context, the students get to know the requirements of the German guidelines in transport planning and can apply them to planning tasks. Through the in-depth examination of the theory and practice of transport demand modelling, the students are enabled to carry out own planning studies and to quantitatively evaluate planning alternatives. They are thus qualified to make reliable recommendations for the development of the transport infrastructure.

Literature

- Ortúzar, J. de D.; Willumsen, L. G. (2011): Modelling Transport. 4th Edition. Chichester/Hoboken: John Wiley & Sons. ISBN 978-0-470-76039-0
- Sheffi, Y. (1985): Urban Transportation Networks: Equilibrium Analysis with Mathematical Programming Methods. Englewood Cliffs, NJ: Prentice-Hall. ISBN 978-0-13-939729-5

• Forschungsgesellschaft für Straßen- und Verkehrswesen (FGSV) (Hrsg.) (2022): Empfehlungen zum Einsatz von Verkehrsnachfragemodellen für den Personenverkehr – EVNM-PV. Köln: FGSV Verlag. FGSV-Nr. 168/2. Forschungsgesellschaft für Straßen- und Verkehrswesen (FGSV) (Hrsg.) (2008): Richtlinien für integrierte Netzgestaltung – RIN. Köln: FGSV Verlag. FGSV-Nr. 121. ISBN 978-3-939715-79-5

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Transport Policy		
Number	3329000010	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Planung des öffentlichen Verkehrs
Hours per Week / ECTS	4 / 6,0	**Module owner**	Alejandro Tirachini Hernández
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam+ (120 Min.)		
Course achievement			
Examination language	english		

Contents

- Motivation: why transport policy

- Reasons for public sector intervention on the transport sector

- Transport externalities

- Transport policy instruments:

•Supply side: provision of infrastructure and services

•Supply side: pricing (taxes, subsidies, fare setting)

•Demand side: demand management tools

•Policy packages

- Social effects of transport policy (e.g., social inclusion, transport poverty)

- Regional perspectives on transport policy

Objective qualification

The students acquire an in-depth understanding of the guiding principles behind transport policy decisions. Upon successful completion, students will be able to: (1) understand the reasons behind transport policy and the need for policy interventions on the transport sector, (2) analyse transport externalities as a reason for policy intervention, (3) examine the main types of transport policy instruments that are applied in different parts of the world, (4) predict the effects of specific transport policies in future scenarios.

Literature

Presentation, article, book chapter (See lecture)

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	english

Title	Service Planning and Transport Strategies for Railways		
Number	4302050	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Planung des öffentlichen Verkehrs
Hours per Week / ECTS	4 / 6,0	**Module owner**	Alejandro Tirachini Hernández
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Oral Exam (30min) (in the Master's programme in Social Sciences as a course achievement)		
Course achievement			
Examination language	german		

Contents

-Transport Policy
-Transport economics
-Track problems
-Transport planning in passenger and freight transport
-Supply strategies in passenger and freight transport

Objective qualification

Students learn about the political environment and the market aspects of rail transport. Under these boundary conditions, the supply planning and the transport strategies of both freight and passenger transport are taught. After completing the module, the students are able to take a differentiated look at the different forms of rail transport.

Literature

Vorlesungsskript

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Railway Operation		
Number	4310610	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Schienenverkehrssysteme
Hours per Week / ECTS	5 / 6,0	**Module owner**	Prof. Dr. Lars Schnieder
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (60 Min.) or oral exam (approx. 30 Min.)		
Course achievement	Termpaper (approx. 30 h workload)		
Examination language	german		

Contents

- Basic operating terms and definitions
- Capacity research (capacity evaluation, analytical methods, simulation)
- Timetabling (traffic diagrams, time elements, running time calculation, planning of conflict-free train paths, cyclic timetables)
- Train path management (market structure, train path pricing, facility prices, station stop prices, train path requesting and assigning procedure)
- Traffic control (employees in traffic control, train movements in normal and degraded mode operations, shunting)
- Marshalling yards (purpose and structure of a marshalling yard, sorting procedure, hump dynamics, retarders)

Objective qualification

The students get profound knowledge on planning, management and control of train traffic. As employees of railway infrastructure companies or consulting firms, they are able to evaluate the operational capacity of the railway infrastructure, to select appropriate operational procedures, and to develop timetable concepts. They can take job positions in timetabling train path management and in supervision of train traffic control. They can also work in teams for the operational planning of construction and maintenance works. The students are familiar with the application of IT tools for capacity research and timetabling. They have the ability to evaluate the operational performance of railway lines and nodes under consideration of the constraints resulting from the infrastructure, and from signalling and vehicle constraints.

Literature

- Pachl, J.: Systemtechnik des Schienenverkehrs. 9. Aufl.,
- Vieweg Springer, Wiesbaden 2018, in der LV verteilte Materialien

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	5,0	Lecture/Exercise	german

Title	Railway Signalling		
Number	4310630	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Schienenverkehrssysteme
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Jörn Pachl
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (60 Min.) or oral exam (approx. 30 Min.)		
Course achievement	Term paper (approx. 30 h workload)		
Examination language	german		

Contents

- Relevant operational terms and definitions
- Systems safety criteria (classification of failures, human factors, safety strategies)
- Trackside elements controlled by signalling systems (lineside signals, points and crossings, line clear detection)
- Block systems (manual block systems, automatic block systems)
- Interlocking (route locking and release, flank protection, overlaps, interlocking systems)
- Automatic train protection (intermittent and continuous ATP, PZB 90, LZB , ETCS)
- Level crossings

Objective qualification

The students get a profound understanding of the fundamental elements and principles of railway signalling systems. As employees of railway infrastructure companies or engineering firms, they can select appropriate signalling technologies for a given use case and support the signal planning. As employees of a signalling manufacturing company, they can give advice to customers of how to apply signalling technology on their lines. Together with engineers of other trades, they can work in research & development teams of the signalling industry

Literature

- Maschek, U.: Sicherung des Schienenverkehrs - Grundlagen und Planung der Leit- und Sicherungstechnik, Springer Vieweg, Wiesbaden 2012
- Pachl, J.: Systemtechnik des Schienenverkehrs, 9. Aufl., Vieweg Springer, Wiesbaden 2018
- Theeg, G.; Vlasenko, S. (Hrsg).: Railway Signalling & Interlocking - International Compendium, Eurailpress, Hamburg 2009
- Naumann, P.; Pachl, J.: Leit- und Sicherungstechnik - Fachlexikon, 2. Aufl., Tetzlaff Verlag, Hamburg 2004

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	5,0	Lecture/Exercise	german

Title	Engineering Process for Railway Signaling Systems		
Number	4310620	**Module version**	V1
Shorttext		**Language**	german
Frequency of offer		**Teaching unit**	
Module duration	1	**Institution**	Institut für Schienenverkehrssysteme
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Lars Schnieder
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (60 min.) or oral exam (approx. 30 min.)		
Course achievement			
Examination language	german		

Contents

The module provides fundamental and advanced knowledge of the development process of railway signalling systems in the context of safety-critical railway systems. Students gain a structured understanding of the regulatory, methodological, and technical foundations required for the development, testing, and approval of signalling systems. A particular focus is placed on distinguishing between the development of generic applications and the development of specific applications, taking into account the applicable standards and regulations in railway signalling engineering. In this context, fundamental methods and processes are taught, including:
- legal foundations and standardisation in the field of railway signalling systems
- concepts of risk and safety in safety-critical systems
- application of the V-model in the development process of both generic and specific applications
- methods of risk and hazard analysis
- requirements definition, system definition, and functional allocation within the system
- verification and validation of safety-related systems
- safety cases for generic and specific applications
- approval and certification processes for generic and specific applications

Objective qualification

Students are able to explain the legal foundations, standards, and regulations of railway signalling technology and to classify their relevance for the development of safety-critical systems. Students are able to describe the development process of railway signalling systems based on the V-model and transfer it to both generic and specific applications. Students are able to perform risk and hazard analyses using appropriate methods and to evaluate their results for system development purposes. Students understand the structure and composition of safety cases for both generic and specific applications, taking into account relevant normative requirements. Students are able to explain and classify the fundamental steps and requirements of approval and certification processes in the field of railway signalling systems.

Literature

- Braband, J. et al.: Die CENELEC-Normen zur Funktionalen Sicherheit. Eurailpress (Hamburg) 2006.
- Braband, J.: Risikoanalysen in der Eisenbahn-Automatisierung. Eurailpress (Hamburg) 2005.

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Design of Railway Infrastructure		
Number	4310600	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Schienenverkehrssysteme
Hours per Week / ECTS	7 / 6,0	**Module owner**	Prof. Dr. Lars Schnieder
Workload (h)	180		
Class attendance (h)	70	**Self studying (h)**	110
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Examination language	german		
Contents			
Objective qualification			
Literature			
Wird in der Lehrveranstaltung bekanntgegeben.			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	5,0	Lecture/Exercise	german
	2,0	Exercise	german

Title	Digital Planning, Construction and Operation of Rail Systems		
Number	3318000000	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	1	**Institution**	
Hours per Week / ECTS	4 / 6,0	**Module owner**	
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Recommended requirements	Knowledge from the Railway Construction module or comparable content is recommended		
Expected performance/ Type of examination	Written exam (60 min.) or oral exam (approx. 30 min.)		
Course achievement			
Examination language	german		

Contents

The course provides fundamental and advanced knowledge on the digital support of the entire life cycle of railway systems. It begins with the digital capture of the as-built condition of rail infrastructure using modern surveying and measurement techniques. Building on this, digital methods and tools for the planning and modelling of rail infrastructure are introduced, particularly Building Information Modeling (BIM). A special focus is placed on the integration of different disciplines (e.g. alignment design, structural engineering, and signalling and control systems) as well as on consistent data management throughout the entire planning process. Subsequently, the course addresses digital processes for coordinating and executing planning tasks, as well as for supporting approval and authorization procedures in the railway sector. Regulatory requirements and the specific framework conditions of railway infrastructure are also taken into account. Finally, the module covers the digital support of construction and operation of railway systems. This includes, among other aspects, construction scheduling under ongoing railway operations, digital monitoring, maintenance management, and data-driven operation and asset management strategies. Particular emphasis is placed on the continuous use of digital models and data in the sense of a digital twin

Objective qualification

Students are able to understand the significance of digitalization for the life cycle of railway systems and to evaluate it in the context of the specific requirements of the railway sector. Students understand methods for the digital capture of the as-built condition of railway infrastructure and are able to assess their fields of application. Students are able to apply digital planning methods for railway systems, in particular model-based approaches (e.g. BIM for linear infrastructure), and to critically evaluate them. Students are able to purposefully use digital tools for the interdisciplinary coordination of complex planning processes in the railway domain. Students understand the fundamental processes of digitally supported approval and authorization procedures for railway infrastructure. Students are able to describe digital technologies used in the construction and operation of railway systems and to assess their benefits.

Literature

Jochen Holzfeind, Jia Liu, Ferdinand Pospischil: Handbuch Eisenbahninfrastruktur. Springer (Berlin 2025)

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
		Lecture/Exercise	german

Title	Seminar on Signal System Design and Planning		
Number	3318000010	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration		**Institution**	
Hours per Week / ECTS	5 / 6,0	**Module owner**	Prof. Dr. Lars Schnieder
Workload (h)	180		
Class attendance (h)	70	**Self studying (h)**	110
Compulsory requirements			
Expected performance/ Type of examination	Oral exam (30 min)		
Course achievement	Portfolio (written documentation of the independent planning of a model railway station, including a planning report of up to 10 pages, using planning software)		
Examination language	german		

Contents

The course provides fundamental knowledge of railway signalling system planning, including its content, processes, and methods. It introduces signalling planning in accordance with HOAI (Verordnung über die Honorare für Architekten- und Ingenieurleistungen). Selected planning tools are applied in a practical project setting to support implementation. Furthermore, the role of the engineer, as well as the potentials and limitations of technological support, are critically reflected.

Objective qualification

• Students are able to describe and explain the content and workflow of railway signalling system planning (PT1).
• They are able to describe the individual planning steps within the context of railway system planning and to situate the role of PT1 within the overall process leading to technical implementation (PT2).
• They are able to contextualise the role of planning within the lifecycle of railway systems.
• They are able to apply selected planning tools to develop key planning documents.
• They are able to reflect on the division of tasks between engineers and IT tools, and to evaluate the potentials and limitations of technological support.

Literature

-Sicherung des Schienenverkehrs: Grundlagen und Planung der Leit- und Sicherungstechnik, Ulrich Maschek Systemtechnik des Schienenverkehrs -Bahnbetrieb planen, steuern und sichern, Jörn Pachl

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
		Seminar	german

Title			
Number	3320000010	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Straßenwesen
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Michael Wistuba
Workload (h)	180		
Class attendance (h)	84	**Self studying (h)**	96
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Examination language	german		

Contents

[Bituminous binders (VÜ)]

The binder in asphalt mixtures, the main construction material in road infrastructure, is bitumen. Its properties (temperature behavior, aging, adhesion behavior, reuse) are carefully tested in the laboratory because they have a significant influence on the performance of asphalt mixtures. In this course, rheological test methods are presented that are used in modern asphalt mixture technology and serve to increase the sustainability of asphalt mixtures. With their help, it is possible to assess alternative bituminous binders (e.g. bio-asphalt) and/or additive binders with regard to their effect on the road, e.g. with regard to increasing durability, the regenerative effect in asphalt mixture recycling or the reduction of environmental pollution.

[Performance of asphalt mixtures (VÜ)]

In this course, the requirements for the road structure (such as skid resistance, crack and resistance to permanent deformation, ageing resistance) are defined and suitable mechanical laboratory test methods are presented. In particular, it is shown how a specific asphalt mixture can be systematically tested in the laboratory on the basis of the performance properties of the composed and compacted asphalt mixture. Optimization conflicts with regard to the requirements are presented and possibilities for reacting to them in the best possible way through targeted formulation and design of the asphalt mixture composition.

[Road construction laboratory course (P)]

In the course, students carry out selected tests in the institute's own laboratory. For example, soil parameters are determined under supervision (density, water content, compaction), tests are carried out to determine the condition in situ (load-bearing capacity, evenness, skid resistance) and specimens are produced

by a supervisor from rolled and mastic asphalt mixtures, the composition and characteristic values of which are then checked in the laboratory.

Objective qualification

Students gain in-depth knowledge of asphalt technology in order to understand the complex optimization process in the design of asphalt mixes and to carry out systematic testing in the laboratory, taking into account all performance properties. They will be able to carry out fundamental and rheological laboratory tests to determine the mechanical properties of construction materials and interpret the results correctly. Using selected material models, they will become familiar with the tools for predicting the performance of road construction materials in order to evaluate the effectiveness and quality of different types of construction materials. This is of particular interest against the background of the further development of sustainable road construction technology. They will then be able to critically evaluate existing asphalt construction methods and contribute to the development of new asphalt construction methods. In addition, they are qualified to promote the reuse of reclaimed asphalt at a high value-added level. Students also learn how to produce and test typical road construction test specimens. They will be able to estimate the costs and benefits of standard test procedures and correctly evaluate and interpret test results. They acquire in-depth theoretical and practical knowledge of the methods used to test the suitability and quality of raw materials, building material mixtures and additives, as well as the technical implementation of asphalt recycling.

Literature

Richtlinien und Empfehlungen

Vorlesungsskripte

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Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language
Bituminous binders	2,0	Lecture/Exercise	german
Performance of asphalt mixtures	2,0	Lecture/Exercise	german
Road construction laboratory course	2,0	Internship	german

Title	Road Planning and Dimensioning		
Number	3320000030	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Straßenwesen
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Michael Wistuba
Workload (h)	180		
Class attendance (h)	84	**Self studying (h)**	96
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Examination language	german		

Contents

[Road planning and design (VÜ)

In this course, road planning is presented from the determination of the need for the construction of a road to its implementation. The planning process, the planning levels with their different levels of detail, environmental concerns, public participation, legal issues, the financing of public roads, the planning design of junctions and intersections, proof of traffic quality as well as economic efficiency and life cycle analysis are discussed.

[Computer-supported dimensioning and design of roads (VÜ)]

This course teaches the fundamentals of the structural design of road pavements and the computational dimensioning. The main focus is on highly loaded roads and flexible (asphalt) and rigid construction methods (cement concrete). The model representation of the layer structure, the time and load-dependent behavior of the construction material, the bonding of the layers and the load-bearing behavior of the subsoil are explained. The course also demonstrates practical planning and design work on a specific road construction project using the VESTRA CAD road planning program. It begins with the three-dimensional site survey, after which all planning tasks relating to the alignment, gradient and cross-section design are processed and solved with computer support.

[Digitalization in the road sector (VÜ)]

The course "Digitalization in the road sector" provides basic knowledge and practical methods for digital transformation in the field of road infrastructure. The focus is on current technologies and strategies that are used to optimize the planning, construction, operation and maintenance of roads. Students are introduced to the challenges and potentials of digitalization and learn how digital systems and smart technology approaches can change traditional work processes in the transport and road sector in the long term. This includes, for example, sensor technologies for condition monitoring (Pavement Monitoring System) or the methods of Building Information Modeling (BIM) in the planning of infrastructure projects.

Objective qualification

The qualification objective is the independent planning of road projects from project initiation, variant planning, dimensioning of the road structure, structural design through to the preparation of tender documents including the documentation of technical and economic decisions. Students understand the holistic planning process in its individual planning stages (preliminary planning, design planning, approval planning) and recognize the legal, financial and environmental framework conditions of public road projects. On the basis of a realistic example of a road project, students combine their specialist knowledge with application, creating specifications, cost and schedule plans, variant studies and tender documents. They take into account economic, ecological and social criteria as well as the contents of a life cycle analysis. In the area of structural design and computational dimensioning, they are proficient in the modeling and dimensioning of multi-layer road structures, can apply building material and load-bearing behavior models and are proficient in the use of planning software (e.g. VESTRA CAD). They can create terrain models, develop route variants and optimize gradient and cross-section constructions with the aid of computers. The project-oriented group work sharpens their team and communication skills and prepares them to work on road projects independently and in a solution-oriented manner.
Literature
Richtlinien und Empfehlungen Vorlesungsskripte

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german
	2,0	Lecture/Exercise	german
	2,0	Exercise	german

Title	Sustainable Road Construction		
Number	3320000020	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Straßenwesen
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Michael Wistuba
Workload (h)	180		
Class attendance (h)	84	**Self studying (h)**	96
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Examination language	german		

Contents

[Road construction materials (VÜ)]

The course begins with the question of the requirements for road construction materials (skid resistance, crack resistance, ageing resistance) and then explains how these can be met through the targeted selection, formulation and mix design of construction materials. The quality of aggregates, binders and construction material mixtures, binder modification, reuse of construction materials, determination of the layer structure and prediction of the service life of road pavements are discussed in more detail.

[Road construction technology (VÜ)]

The course deals with the technical handling and implementation of road construction projects. The transportation, paving and quality assurance of road pavements are dealt with in a practical manner. Road maintenance is then discussed. The methods for recording and assessing the condition of surface and layer properties, structural and operational road maintenance (especially winter road maintenance) and the recovery and reuse of road construction materials are explained in detail. Numerous application examples are used to prepare students for construction site-related and operational issues in road construction.

[Road construction technology in practice VÜ)]

Using selected examples from the design and production of building materials and building material components, from road construction and from the testing of new/innovative construction equipment or construction methods, the course offers an insight into the current and future practice of road construction technology. This is supported by excursions and specialist lectures by people from the construction industry.

Objective qualification

Students learn that the sustainability of road constructions depends largely on the formulation of the construction material mixtures and their composition to form a layered load-bearing system. They will be able to assess the basic suitability of building materials for road construction, for example, to recognize rocks for road construction or to interpret the quality of bituminous binders on the basis of results from laboratory tests. Students learn how to produce and test typical road construction specimens. They will be able to esti-

mate the costs and benefits of standard test methods and correctly evaluate and interpret test results. They will acquire in-depth theoretical and practical knowledge of the methods used to test the suitability and quality of raw materials, construction material mixtures and additives as well as the technical implementation of asphalt recycling. Students also gain in-depth knowledge of the life cycle of road constructions, starting with the delivery of construction materials, through installation and use, to reuse.

Literature

Richtlinien und Empfehlungen

Vorlesungsskripte

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Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language
Road Construction Materials	2,0	Lecture/Exercise	german
Road Construction Technology	2,0	Lecture/Exercise	german
Road Construction Technology in Practice	2,0	Lecture/Exercise	german

Title			
Number	3320000000	**Module version**	
Shorttext		**Language**	english
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Straßenwesen
Hours per Week / ECTS	2 / 6,0	**Module owner**	Prof. Dr. Michael Wistuba
Workload (h)	180		
Class attendance (h)	28	**Self studying (h)**	152
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Examination language	english		

Contents

The seminar provides insight into research in the field of road pavement engineering in general (including topics, boundary conditions, internationality, interdisciplinarity, scientific language) and imparts knowledge of scientific working methods in the subject area. Students work independently on a sub-question within one of the research topics by studying sources, write a short paper on the topic and give a short presentation. In this way, they are introduced to scientific work and acquire essential core competencies for a targeted, methodologically sound and comprehensible preparation and summary of selected research topics as preparation for independent scientific work and publication (e.g. also as part of a dissertation).

Objective qualification

Students gain insight into current international research in the field of road pavement engineering (in particular asphalt technology, testing, rheological modeling) and are enabled to grasp the state of the art in selected specific questions from the field of research, to critically analyze it using scientific methods and to formulate new research questions.

Literature

International Journal Papers

Richtlinien und Empfehlungen

Vorlesungsskripte

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
		Seminar	english

Title	Transport Planning		
Number	4318020	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Verkehr und Stadtbauwesen
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Bernhard Friedrich
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) or oral exam (30 Min.)		
Course achievement	Homework assignment		
Examination language	german		

Contents

[Verkehrsplanung (VÜ)]
- Introduction to transport planning
- Planning Methodology
- Behavioural traffic surveys
- Planning of transport networks
- Planning of measures in public transport (external lecturer from the field)
- Decision models
- Traffic models (traffic generation, traffic distribution, traffic allocation)
- Impact models and evaluation procedures
- Traffic safety

Objective qualification

The students gain an overview of the characteristics of mobility, the socio-economic significance of transport that can be derived from this and the resulting legal anchoring of spatial and transport planning. Based on the understanding of the problems and tasks of transport planning, the planning methodology and the instruments of transport network planning in public transport and individual transport are introduced. In this context, the students get to know the requirements of the German guidelines in transport planning and can apply them to planning tasks. Through the in-depth examination of the theory and practice of transport demand modelling, the students are enabled to carry out own planning studies and to quantitatively evaluate planning alternatives. They are thus qualified to make reliable recommendations for the development of the transport infrastructure.

Literature

- Ortúzar, J. de D.; Willumsen, L. G. (2011): Modelling Transport. 4th Edition. Chichester/Hoboken: John Wiley & Sons. ISBN 978-0-470-76039-0

- Sheffi, Y. (1985): Urban Transportation Networks: Equilibrium Analysis with Mathematical Programming Methods. Englewood Cliffs, NJ: Prentice-Hall. ISBN 978-0-13-939729-5
- Forschungsgesellschaft für Straßen- und Verkehrswesen (FGSV) (Hrsg.) (2022): Empfehlungen zum Einsatz von Verkehrsnachfragemodellen für den Personenverkehr – EVNM-PV. Köln: FGSV Verlag. FGSV-Nr. 168/2. Forschungsgesellschaft für Straßen- und Verkehrswesen (FGSV) (Hrsg.) (2008): Richtlinien für integrierte Netzgestaltung – RIN. Köln: FGSV Verlag. FGSV-Nr. 121. ISBN 978-3-939715-79-5

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Urban Road Design		
Number	3319000000	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Verkehr und Stadtbauwesen
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Bernhard Friedrich
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Portfolio		
Course achievement			
Examination language	german		

Contents

- Requirements for a sustainable and climate-friendly design of urban roads
- Design principles and utilisation requirements for urban roads
- Guidelines and recommendations for the design and layout of urban roads
- User and mode of transport-specific design elements for road sections and junctions
- Design and layout of facilities for motorised private transport
- Design and layout of facilities for pedestrian traffic
- Design and layout of facilities for bicycle traffic
- Design and layout of facilities for local public transport
- Accessibility
- Project study in collaboration with the city of Braunschweig

Objective qualification

(E) The planning and design of sustainable urban streets is based on objectives derived from the quality of sojourn and functionality. To this end, the existing road users' requirements, aspects of accessibility, traffic safety and ecological compatibility are considered. Students are given a systematic overview of these requirements for a sustainable street space and learn how to take them into account in the design process. They will also be able to apply the state of the art of the relevant recommendations and guidelines. Students acquire practical skills as part of a project study in which they design a real street space, taking appropriate account of all user requirements and boundary conditions. In cooperation with the city of Braunschweig, exemplary streetscapes are selected and worked on in small groups in order to implement, coordinate and finally present what has been learnt in the lecture in a practical exercise.

Literature

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
Urban Road Design	4,0	Lecture/Exercise	german

Title	Traffic Management		
Number	3319000010	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Verkehr und Stadtbauwesen
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Bernhard Friedrich
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam+ (90 Min.) or oral examination (ca. 30 Min.) Two assignments can be completed in advance which, if passed, count for 25% of the final grade for the module. The application for an written exam+ must be submitted by the student at the start of the examination. Further information on deadlines for the submission of term papers is provided in the courses of the module.		
Course achievement			
Examination language	german		

Contents

- Functional and organisational system architectures for the management of road traffic facilities
- Traffic flow theory as the basis for determining the traffic situation and evaluating measures
- Recording, processing and analysing traffic data (practical course)
- Design and traffic engineering dimensioning of road traffic facilities
- Procedures and methods of traffic control for road network, road sections and junctions within (urban roads) and outside built-up areas (motorways)
- Procedures for determining the traffic situation and quality management
- Insights into practice through guest lectures and excursions

Objective qualification

Students gain a comprehensive overview of the responsibilities, tasks and objectives of the management of road traffic facilities inside and outside built-up areas. In this context, system architectures for traffic management in Germany are introduced in their functional and organisational forms. Students learn the basics of traffic data analysis and traffic flow theory in order to be able to competently deal with the tasks of traffic management and, building on this, to apply state-of-the art methods for the dimensioning of road traffic facilities and the various methods of traffic control in accordance with the regulations applicable in Germany. This gives students the skills to develop and evaluate measures that make sense from a traffic flow perspective and are ecologically and economically suitable. Taking into account the existing traffic infrastructure, they will be able to dimension road traffic systems on urban roads and motorways that meet the standards of German guidelines and equip them with the necessary traffic engineering systems (operation).

Literature

- Treiber, M., & Kesting, A. (2010). Verkehrsdynamik und -simulation: Daten, Modelle und Anwendungen der Verkehrsflussdynamik. Springer. https://doi.org/10.1007/978-3-642-05228-6 Boltze, M. (2025): Straßenverkehrsmanagement – Eine Einführung in die Beeinflussung von Angebot und Nachfrage. Bonn: Kirschbaum Verlag. ISBN 978-3-7812-2165-9

- Forschungsgesellschaft für Straßen- und Verkehrswesen (FGSV) (Hrsg.) (2015): Handbuch für die Bemessung von Straßenverkehrsanlagen – HBS. Köln: FGSV Verlag. FGSV-Nr. 299. ISBN 978-3-86446-103-3
- Bundesministerium für Verkehr, Bau und Stadtentwicklung (BMVBS); Bundesanstalt für Straßenwesen (BASt) (Hrsg.) (2012): Technische Lieferbedingungen für Streckenstationen (TLS). FGSV-Nr. 3049. Köln: FGSV Verlag. Bundesministerium für Verkehr und digitale Infrastruktur (BMVI) (Hrsg.) (2018): Merkblatt für die Ausstattung von Verkehrsrechnerzentralen und Unterzentralen (MARZ 2018). Bergisch Gladbach: Bundesanstalt für Straßenwesen (BASt). Bundesministerium für Verkehr und digitale Infrastruktur (BMVI) (Hrsg.) (2022): Dynamische Wegweiser mit integrierten Stauinformationen (dWiSta) – Hinweise für die einheitliche Gestaltung und Anwendung an Bundesfernstraßen. Bergisch Gladbach: Bundesanstalt für Straßenwesen (BASt)

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
Traffic Management	4,0	Lecture/Exercise	german

Title	Research Seminar Traffic Planning and Traffic Engineering		
Number	4398080	**Module version**	
Shorttext		**Language**	english german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Verkehr und Stadtbauwesen
Hours per Week / ECTS	2 / 6,0	**Module owner**	Prof. Dr. Bernhard Friedrich
Workload (h)	180		
Class attendance (h)	28	**Self studying (h)**	152
Compulsory requirements			
Expected performance/ Type of examination	Presentation		
Course achievement			
Examination language	english german		

Contents

In this seminar, specific questions from the research fields of traffic planning and traffic engineering are dealt with on changing topics. The seminar topics are embedded in the current research work or research content of the Institute of Transport and Urban Engineering. The students gain an insight into current research topics in traffic planning and traffic engineering and have the opportunity to actively participate and shape them.

- introduction, discussion of research topics
- presentation and discussion of first ideas for individual research questions
- literature review methods -overview to methods
- literature review methods -exercise
- intro on how to write a scientific paper
- development and formulation of own, individual research questions
- preparation of a short scientific paper on the individual research topic
- presentation and discussion of individual research questions

Objective qualification

The seminar imparts knowledge in the planning and implementation of research projects and gives an in-depth insight into scientific working methods. The students independently work out a partial question within one of the research topics by studying sources, write a short paper on it and present it in a short presentation. The students are thus guided to in-depth scientific work and acquire essential core competences for a goal-oriented, methodically clean and comprehensible preparation and summary of selected research topics

Literature

Die Recherche der maßgebenden aktuellen Literatur und deren Erfassung ist Bestandteil des Forschungsseminars

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
Research Seminar Traffic Planning and Traffic Engineering	2,0	Seminar	english german

Title	Microscopic Traffic Flow Simulation and its Applications		
Number	4301910	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Verkehr und Stadtbauwesen
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Bernhard Friedrich
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	written exam (90 Min.) or oral exam (30 Min.)		
Course achievement			
Examination language	german		

Contents

- Traffic surveys
- Microscopic traffic flow modelling
- Calibration and validation methods
- Traffic-actuated control methods
- Applications of microsimulation using professional software

Objective qualification

The students acquire basic knowledge of the theoretical principles of microscopic traffic flow models, for the collection of input, calibration and validation data as well as for the statistically correct evaluation of simulation results. They are enabled to plan and carry out traffic surveys and to check traffic and design planning with the help of microsimulation using the collected data.
In the course of the lecture, the students learn how to use a simulation tool and are enabled to independently set up and carry out simulations with the software.

Literature

- Treiber, M., & Kesting, A. (2010). Verkehrsdynamik und -simulation: Daten, Modelle und Anwendungen der Verkehrsflussdynamik. Springer. https://doi.org/10.1007/978-3-642-05228-6 Forschungsgesellschaft für Straßen- und Verkehrswesen (FGSV) (Hrsg.) (2006): Hinweise zur mikroskopischen Verkehrsflusssimulation – Grundlagen und Anwendung. Köln: FGSV Verlag, FGSV-Nr. 388, ISBN 3-939715-11-5.

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Extended Basics

Title	Materials Science for Civil Engineering		
Number	4398400	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	2	**Institution**	Fachgebiet Baustoffe
Hours per Week / ECTS	8 / 8,0	**Module owner**	Dr. Thorsten Leusmann
Workload (h)	240		
Class attendance (h)	112	**Self studying (h)**	128
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Examination language	german		
Contents			
Objective qualification			
Literature			
• Übungsunterlagen • ausführliches Vorlesungsmanuskript			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german
	4,0	Lecture/Exercise	german

Title	Construction Industry and Operation		
Number	4321010	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Bauwirtschaft und Baubetrieb
Hours per Week / ECTS	5 / 6,0	**Module owner**	Prof. Dr. Patrick Schwerdtner
Workload (h)	180		
Class attendance (h)	70	**Self studying (h)**	110
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 Min.)		
Course achievement			
Examination language	german		

Contents

Lean Construction; production planning; introduction to construction methods and processes; general site facilities; performance estimation of construction machinery; introduction to construction machinery; introduction to occupational health and safety measures; machinery and methods of soil engineering; lifting devices; formwork; Logistics of concrete and masonry work;
characteristics of construction; introduction to sustainable planning and construction; organizational and operational structure; tendering and contracting; wages and salary;
Work time values; methods of cost estimation; building contract; introduction to quality management; application of Building Information Modeling (BIM)

Objective qualification

After completing the module, students will be able to apply basic knowledge of production planning, scheduling and construction process engineering to the execution of construction works. They will be able to determine the general facilities as well as machinery and equipment required for a construction project as well as determine their performance. Furthermore, the students acquire the ability to apply the principles of cost and performance accounting to simple projects. In this context, the students are able to take into account selected aspects of construction contract law and quality management for the project preparation and implementation.

Literature

Lehrmaterial:
Skript zur Vorlesung "Grundlagen der Bauverfahrenstechnik"

Lehrmaterial:
Übungsskript zur Vorlesung "Grundlagen der Bauverfahrenstechnik"

Lehrmaterial:
Skript zur Vorlesung "Grundlagen der Bauwirtschaft"

Lehrmaterial: Übungsskript zur Vorlesung "Grundlagen der Bauwirtschaft"

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	3,0	Lecture	german
	2,0	Exercise	german

Title	Computer Networks 1		
Number	4213330	**Module version**	V2
Shorttext		**Language**	
Frequency of offer	only in the summer term	**Teaching unit**	Carl-Friedrich-Gauß-Fakultät
Module duration	1	**Institution**	Institut für Betriebssysteme und Rechnerverbund
Hours per Week / ECTS	4 / 5,0	**Module owner**	Prof. Dr. Lars Wolf
Workload (h)	150		
Class attendance (h)	56	**Self studying (h)**	94
Compulsory requirements			
Expected performance/ Type of examination	1 graded work: Written exam (90 minutes) or Take-Home-Exam.		
Course achievement			
Examination language			

Contents

- Historical classification
- Overview of networks and protocols
- Layer models and layers
- Protocol mechanisms
- Brief introduction to Internet protocols

Objective qualification

After completing this module, students will have a basic understanding of how computer networks work.
- They will be able to describe how processes in computer networks work.
- Furthermore, students will have gained a fundamental understanding of the effects of distribution and communication through networks and how to deal with them.

Literature

Andrew Tanenbaum, David Wetherall, Nick Feamster, Computer Networks, 6.Ed. 2021, Print-ISBN: 978-1-292-37406-2, E-ISBN: 978-1-292-37401-7
James Kurose, Keith Ross. Computer Networking. A Top-Down Approach, 2021, 8th edition, Print-ISBN: 978-1-292-40546-9, E-ISBN: 978-1-292-40551-3.

↑

Related courses
Rules for the choice of courses
Compulsory attendance

Name of the course	SWS	Eventtype	Language
Computer Networks	4,0	Lecture/Exercise	german

Literature
- Andrew S. Tanenbaum; David J. Wetherall: Computer Networks. International Edition. 5th edition. Pearson, 2010. ISBN-10: 0132553171 / ISBN-13: 9780132553179 - James F. Kurose; Keith W. Ross: Computer Networking: A Top-Down Approach. International Edition. 6th edition. Pearson, 2012. ISBN-10: 0273768964 / ISBN-13: 9780273768968

Title	Rotary Wing - Basics		
Number	2514570	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für Flugführung
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Peter Hecker
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Recommended requirements	Basic knowledge of aerodynamics, technical mechanics and vibration theory		
Expected performance/ Type of examination	1 examination element: oral exam, 45 minutes		
Course achievement			
Examination language	german		

Contents

A historical review of the development of rotating wing aircraft is given first. Performances of today's helicopters and their importance will be outlined, the different rotating wing vehicles, the possibilities to drive the rotors and the various means of torque compensation are discussed and differences to fixed-wing aircraft will be shown. Fundamentals of rotor aerodynamics are demonstrated for the various operational conditions such as hovering flight, vertical climb and descent, and level forward flight. The computational methods are first the energy-based momentum theory and second the blade element theory, including interference effects, for example due to fuselage aerodynamcis. The elements of rotor blade motion (natural frequencies, dynamic response problem) will be addressed. The trimming of the helicopter in the different operational conditions, the total power required, and helicopter performances such as maximum climb ratio, endurance, range, ceiling height, maximum speed are covered. Finally the design of helicopters is outlined.

Objective qualification

The students will learn how to compute rotor aerodynamics for different operational conditions by means of simple momentum theory first, then by refined blade element theory. They will then be able to judge the impact of different rotor design parameters on helicopter rotor performance.

Literature

K. von Gersdorff, K. Knobling, C. Bode, Hubschrauber und Tragschrauber, ISBN 3763761152, Bernard & Graefe, 1999.

W. Bittner, Flugmechanik der Hubschrauber, Springer Verlag, 2001.

A. Gessow, G.C. Myers, Aerodynamics of the Helicopter, Macmillan Co., 1952; ISBN 0 804 44275 4, Continuum International Publishing Group Ltd., 1997.

W. Johnson, Helicopter Theory, ISBN 0 691 07971 4, Princeton University Press, 1980.

W.Z. Stepniewski, C.N. Keys, Rotary-Wing Aerodynamics, ISBN 0486646475, Dover Publications, 1984.

D.M. Layton, Helicopter Performance, ISBN 0 916460 39 8, Matrix Series in Mechanical and Aeronautical Engineering, Matrix Publishers, Inc., 1984.

R. Prouty, Helicopter Aerodynamics, ISBN 9991992162, Phillips Pub. Co., 1985.

J.G. Leishman, Principles of Helicopter Aerodynamics, ISBN 0 521 66060 2, Cambridge University Press, 2001.

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
	1,0	Exercise	german

Title	Electrical Railways		
Number	2423430	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	Fakultät für Elektrotechnik, Informationstechnik, Physik
Module duration	1	**Institution**	
Hours per Week / ECTS	4 / 5,0	**Module owner**	Prof. Dr. Bernd Engel
Workload (h)	150		
Class attendance (h)	56	**Self studying (h)**	94
Compulsory requirements			
Expected performance/ Type of examination	oral exam (30 min)		
Course achievement			
Examination language	german		

Contents

The module provides an overview of electric railway systems and their stationary and mobile electrical components. The closely related electric road bus systems (trolleybus, battery bus with inductive charging) are also considered.
are also considered.
0 . Repetitorium: Fundamentals of electrical engineering and electrical power engineering for electric railways
1 Introduction: Classification of railway vehicles and electric road bus systems
2. national and international stationary traction current systems, DC and AC
3. electric drives
- Historical development of drive topologies
- Inverter systems
- Drive control
- Traction motors and mechanical drive configurations
- Internal combustion vehicles/power transmission types
4. auxiliary systems
- Heating, air conditioning and ventilation
- Batteries, local grid feeds
- Auxiliary converter topologies
5. signalling and security systems
- Overview of the most important systems used in Europe
- On-board equipment
6. control technology on railway vehicles
- Tasks: Control and diagnostics
- Train and vehicle buses and their components
7. passenger information and multimedia
8 Vehicles operated
TRAXX, EuroSprinter, ICE 3, LIREX, ET 423, regional urban railway Regio CITADIS for Kassel, LINT
9. future developments
Fuel cell, electronic transformer, gearless direct drive, hybrid vehicles, contactless energy transmission

energy transmission
10. electric road bus systems (trolleybus, battery bus with inductive/conductive charging)
A free one-day excursion to Alstom Transport Deutschland in Salzgitter and to another destination is also offered.

Objective qualification

After completing the module, students will be able to understand electrical railway systems with regard to the functioning of their components and to evaluate their properties.

Literature

Andreas Steimel: Elektrische Triebfahrzeuge und ihre Energieversorgung: Grundlagen und Praxis. Oldenbourg Industrieverlag
Zarko Filipovic: Elektrische Bahnen: Grundlagen, Triebfahrzeuge, Stromversorgung. Springer Verlag
Biesenack, Hartmut u. a.: Energieversorgung elektrischer Bahnen. Teubner Verlag

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Related courses

Rules for the choice of courses

Compulsory attendance

Name of the course	SWS	Eventtype	Language
	1,0	Exercise	german

Literature

Andreas Steimel: Elektrische Triebfahrzeuge und ihre Energieversorgung: Grundlagen und Praxis. Oldenbourg Industrieverlag
Zarko Filipovic: Elektrische Bahnen: Grundlagen, Triebfahrzeuge, Stromversorgung. Springer Verlag
Biesenack, Hartmut u.a.: Energieversorgung elektrischer Bahnen. Teubner Verlag

	3,0	Lecture	german

Literature

Andreas Steimel: Elektrische Triebfahrzeuge und ihre Energieversorgung: Grundlagen und Praxis. Oldenbourg Industrieverlag
Zarko Filipovic: Elektrische Bahnen: Grundlagen, Triebfahrzeuge, Stromversorgung. Springer Verlag
Biesenack, Hartmut u.a.: Energieversorgung elektrischer Bahnen. Teubner Verlag

Title	GIS and Environmental Informatics		
Number	4398430	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	2	**Institution**	Institut für Geodäsie und Photogrammetrie
Hours per Week / ECTS	4 / 5,0	**Module owner**	Prof. Dr. Markus Gerke
Workload (h)	150		
Class attendance (h)	56	**Self studying (h)**	94
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Examination language	german		
Contents			
Objective qualification			
Literature			
Wird in Vorlesung erörtert.			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Exercise	german
	2,0	Lecture	german

Title	Fundamentals of Information Technology		
Number	2424310	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät für Elektrotechnik, Informationstechnik, Physik
Module duration	1	**Institution**	
Hours per Week / ECTS	5 / 6,0	**Module owner**	Prof. Dr. Ulrich Reimers
Workload (h)	180		
Class attendance (h)	70	**Self studying (h)**	110
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Examination language	german		
Contents			
Objective qualification			
Literature			
- Martin Werner: Nachrichtentechnik, Reihe: Studium Technik, Vieweg+Teubner Verlag, ISBN 3-8348-0456-8, 2009			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
Literature			
Foliensatz zur VL			
	1,0	Lecture	german

	2,0	Lecture	german
Literature			
- Skript - Vorlesungsbegleitendes Multimedia-Lernprogramm (CD) - Martin Werner: Nachrichtentechnik, Reihe: Studium Technik, Vieweg+Teubner Verlag, ISBN 3-8348-0456-8, 2009			

Title	Product Development and Engineering Design		
Number	2516140	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für Konstruktionstechnik
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Thomas Vietor
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Recommended requirements	Fundamental knowledge in the disciplin construction (machine elements, technical mechanics)		
Expected performance/ Type of examination	1 examination element: written exam (120 min) or oral exam (30 min)		
Course achievement			
Examination language	german		

Contents

- Introduction into the construction process and principle technical systems
- Principles of the methodological construction
- Problem-solving thinking and problem-solving-methods (brainstorming, moderation technology, gallery method and method 635)
- Methods for the task explaining and finding-requirements
- Development of fundamental solutions
- Construction-catalog
- General function-structures and physical effects
- Strategies for designing products

Objective qualification

The students are capable of...

- planning, carrying out and review a development project using the general approaches and selected methods
- naming principle methods used for task explanation and development fundamental solutions and by applying them for the development of new products
- naming and applying methods for the consideration of costs and the planning of projects
- depicting, explaining and assessing the physical casual-correlations based on given solution-variables
- explaining the function-definition in the construction methodology, and to rebuild and modify the functions-structure in the development of fundamental solutions
- analyzing challenges by using the learned problem-solution-methods (e.g. gallery method or method 635) and to work out structured solutions

Literature

1. Pahl, G., Beitz, W., Feldhusen, J., Grote, K.-H.: Pahl/Beitz Konstruktionslehre - Grundlagen erfolgreicher Produktentwicklung, Methoden und Anwendung. 7. Auflage, Springer-Verlag, 2007

2. Roth, K.: Konstruieren mit Konstruktionskatalogen Band I - Konstruktionslehre. 3. Auflage, Springer-Verlag, 2000
3. Roth, K.: Konstruieren mit Konstruktionskatalogen Band II - Konstruktionskataloge. 3. Auflage, Springer-Verlag, 2001
4. Haberfellner, R., Daenzer, W. F.: Systems Engineering: Methodik und Praxis. 11. Auflage, Verlag Industrielle Organisation, 2002
5. Lindemann, U.: Methodische Entwicklung technischer Produkte - Methoden flexibel und situationsgerecht anwenden. 3. Auflage, Springer-Verlag, 2009

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Related courses			
Rules for the choice of courses			
Lecture and exercise must be attended.			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
	1,0	Exercise	german

Title	Infrastructure Management		
Number	3341000000	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	2	**Institution**	
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Tanja Kessel
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Infrastructure and Project Financing: 1 written exam (60 min.) Management of Transportation Infrastructure Networks: 1 oral exam (15 min.)		
Course achievement			
Examination language	german		

Contents

The lecture **Infrastructure and Project Financing** focuses on the transfer of knowledge about operational instruments as well as the role and function of financing in the entire life cycle of infrastructure networks, especially road networks. The conflicting priorities between the economical and efficient use of taxpayers' money and the (ecological) sustainability of construction and maintenance measures are highlighted. Special attention is paid to the different incentive mechanisms of the actors and financing participants as well as the different public and private understanding of financing and sustainable action in the context of the normative framework.

In the lecture **Management of Transport Infrastructure Networks**, the connections between organizational and social structures as well as the influences of the various stakeholders on the orientation and implementation of network management tasks with a focus on transport infrastructure are shown. Based on this, various (ecological) sustainability and digitalization strategies of the three main modes of transport in maintenance management as well as methods and tools for application and evaluation are presented. Topics of the resilience of structures in climate change are discussed in the context of ecological sustainability assessment and the economical and efficient use of taxpayers' money.

Objective qualification

In the **Infrastructure and Project Financing** lecture, students learn about various financing structures in infrastructure management and are able to establish the role of financing in the life cycle and in the economic efficiency analysis of infrastructures. They acquire the skills to develop proposed solutions and prepare decisions.

In the lecture **Management of Transportation Infrastructure Networks**, students acquire in-depth knowledge of strategic management activities throughout the life cycle of transportation infrastructure networks. Students acquire the skills to develop a holistic decision-making basis for responsible engineering action in the utilization phase as well as in the feedback to other life cycle phases.

Literature

Präsentationsfolien der Vorlesung, Übungsaufgaben, Literaturliste

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Block course	german
	2,0	Lecture	german

Title	Integrated Production Planning in Construction		
Number	4321070	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Bauwirtschaft und Baubetrieb
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Patrick Schwerdtner
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 min) or oral exam (20 min)		
Course achievement			
Examination language	german		

Contents

Lean Construction Management:
After learning the basics of construction production planning, with a focus on scheduling and resource planning, students are introduced to the methods of lean (construction) management. The difficulties and trade-offs involved in planning and optimising construction production are illustrated, always taking into account the (sub)project objectives. Of particular importance are the project-specific influencing factors, which significantly determine the planned course of construction production and must be taken into account during planning. In this context, the special importance of dealing with interfaces is also made clear. Exercises and team-oriented workshops will be used to explain cycle planning and the last planner method using practical construction scenarios. The face-to-face meetings will take place on the Digital Construction Site to create a real connection and to discuss the possibilities and limitations of digital solutions.

Construction Logistics:
Based on the model of a 'mobile factory', construction logistics tasks in the context of supply, production and waste disposal in the different phases and stages of a construction project are first explained - including their significance from a sustainability perspective (including increasing resource efficiency), Based on this, various construction logistics models are presented (including the department store concept) Digital solutions based on the BIM methodology are also presented The application of various principles of lean construction management leads to an examination of relevant parameters for the planning and control of construction logistics This also includes the determination and visualisation of resource requirements based on an overlay of the quantity take-off and a schedule On this basis, the necessary construction site equipment is analysed in detail, including the dimensioning of the key elements The in-depth exercises are based on real scenarios from construction practice.

Objective qualification

Based on the philosophy and principles of Lean Construction, students will be able to carry out construction production planning taking into account construction logistics requirements. Students will have mastered the basics of scheduling and cycle planning and will be able to determine the resources required. To this end, students will be able to identify different requirements of construction processes and create a project breakdown structure as a basis for scheduling. In addition to the technological interdependencies to be considered, students will gain in-depth knowledge of the accompanying consideration of logistical constraints. By

learning the conceptual principles of supply, production and disposal logistics, students will be able to plan and optimise construction production holistically and identify potential bottlenecks in the relevant production factors at an early stage. Furthermore, students will be able to assess the specific importance of supply chains in the supply of building materials and products to construction production and in reuse and recycling in the context of disposal. To this end, students will be familiar with relevant regulatory requirements and current solutions in the DIY market.
Literature

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german
	2,0	Lecture/Exercise	german

Title	Sustainability and Mobility		
Number	1899310	**Module version**	
Shorttext		**Language**	german
Frequency of offer	irregular	**Teaching unit**	Carl-Friedrich-Gauß-Fakultät
Module duration	1 Semester	**Institution**	
Hours per Week / ECTS	4 / 9,0	**Module owner**	Prof. Dr. Nils C. Bandelow
Workload (h)	270		
Class attendance (h)	56	**Self studying (h)**	214
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement	1 course achievement: • 1 Portfolio: The portfolio documents written and oral competences in the elaboration and presentation of political science issues throughout the module. The portfolio consists of two short, complementary presentations of approx. 15 minutes (or comparable performances such as a poster, debate contribution etc.) and a written paper (approx. 15 pages) or • 1 Oral examination (approx. 20 minutes). The form of the examination will be determined at the beginning of the term.		
Examination language	german		
Module grade composition	Module final examination (9 CP) is as follows: Active participation in two seminars (2 CP) + Preparation and follow-up in two seminars (2 CP) + 1 course achievement (5 CP)		

Contents

- Design processes of mobility and transport by national political institutions and actors as well as new political arenas
- The role of regionalization and Europeanization in shaping mobility and transport
- Innovative capacity and scope for shaping transport industries in times of globalization, climate change and increasing resource consumption
- The transformation of work and employment in the mobility economy
- Corporate goals, conflicts and forms of cooperation in companies of the mobility economy
- Division of labor, occupational structures and training concepts in the mobility economy

Objective qualification

Students have the ability to name and evaluate structures, institutions, theories and areas of conflict in transport policy or economics. They are able to analyze the conditions of the emergence of transport as well as the effects of transport on the economy, science and politics. Furthermore, they will be able to recognize and assess the interdisciplinary dimension of transport research as well as the interests of the actors and conflict potentials in the field. Students acquire the ability to reflect on structural changes in the mobility economy as a social process with diverse and often diverging constellations of actors and interests. They will be able to analyze the implications of technical innovations in the mobility economy for the organization of work, education and training processes. Furthermore, they will be able to relate developments and perspectives in environmental and transport policy to effects on production processes and services. The students

are enabled to transfer and acquire knowledge discursively by means of presentation, discussion and argumentation, including cooperative learning forums and group work.
Literature

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Related courses
Rules for the choice of courses
The module consists of the two subsections “Mobility Processes in Modern Societies” and “Governance in Transport Policy”. Both must be attended.
Compulsory attendance

Name of the course	**SWS**	**Eventtype**	**Language**
Mobility Processes in Modern Societies	2,0	Seminar	german

Literature
International and national institutions and think tanks provide easily accessible documents and current studies for working on the topic clusters in the two seminars "Mobility Processes in Modern Societies" and "Governance of Transport Policy". Examples are: • OECD and International Transport Forum • IEA International Energy Agency; World Energy Outlook. • acatech – Deutsche Akademie der Technikwissenschaften; Mobilität und Klimaschutz • Agora Verkehrswende; Klimaneutralität des Verkehrs. Current mobility statistics are provided by: (1) BMVI: Verkehr in Zahlen; (2) Mobilität in Deutschland (MiD) und (3) Deutsches Mobilitätspanel (MOP) On the current discussion: Prätorius, G., Der „nüchtern-harte“ und der „freundliche“ Weg zu einer neuen und klimaneutralen Mobilität; in: V+T, Verkehr und Technik, Heft 11/2021 (74. Jahrgang), Berlin (https://doi.org/10.37307/j.1868-7911.2021.11.02)

Governance in Transport Policy	2,0	Seminar	german

Literature
International and national institutions and think tanks provide easily accessible documents and current studies for working on the topic clusters in the two seminars "Mobility Processes in Modern Societies" and "Governance of Transport Policy". Selected examples are: • Mercator Institute for Climate and Common Goods (MCC) • Potsdam Institut für Klimafolgenforschung (PIK) • Umweltbundesamt (UBA) The latest mobility statistics are available: (1) BMVI: Verkehr in Zahlen; (2) Mobilität in Deutschland (MiD) und (3) Deutsches Mobilitätspanel (MOP) On the current discussion: Prätorius, G., „Corona-Rebound“ oder Schub für Klimaneutralität – Welche Entwicklung wird der Verkehr nehmen?; in: V+T, Verkehr und Technik, Heft 8/2021 (74. Jahrgang), Berlin, (https://doi.org/10.37307/j.1868-7911.2021.08.02)

Title	Public Building Law		
Number	4318260	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	2	**Institution**	Institut für Verkehr und Stadtbauwesen
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Bernhard Friedrich
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written exam (90 Min.) or oral exam (approx. 30 Min.)		
Course achievement			
Examination language	german		

Contents

[Bauplanungsrecht(VÜ)]
- Fundamentals and objectives of building planning law
- Legal bases: BauGB, BauNVO, BauPlZVO
- Urban land use planning: stages and preparation procedures
- Privatization and security instruments in urban land use planning
- Admissibility of projects
- Consideration and protection of neighbors
- Secured development

[Bauordnungsrecht(VÜ)]
- Fundamentals and goals of the building code
- Legal bases
- Landesbauordnung
- Musterbauordnung
- Implementing ordinance
- special building regulations
- ancillary building regulations
- Types of procedures and approvals
- building documents and responsibilities
- material requirements in the building code
- Regulatory content of the building permit
- protection of neighbors
- ancillary building law
- monument protection law
- immission control law
- Law governing places of assembly
- Workplace law

Objective qualification

Students receive basic knowledge of public building law. This includes the teaching of basic knowledge of building planning law as well as building regulations and ancillary building law (including special regulations). The overarching goal is to teach the relevant sources of law and how to apply them to selected examples. The students thus acquire the competence to comprehend and understanding basic legal system interrelationships in relation to public construction.
Literature

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german
	2,0	Lecture/Exercise	german

Title	Economic Assessment and Procurement of Construction Services		
Number	4321090	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Bauwirtschaft und Baubetrieb
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Patrick Schwerdtner
Workload (h)	180		
Class attendance (h)	84	**Self studying (h)**	96
Compulsory requirements			
Expected performance/ Type of examination	Written exam (120 min) or oral exam (20 min) or Written exam (60 min) or oral exam (15 min) and Course Achievement (successfull participation simulation game)		
Course achievement			
Examination language	german		

Contents

Public Tender and Contract Award:
Starting with the service description as the link between architecture/planning/construction on the one hand and construction on the other, the importance of clear and complete tender documents is explained. After a brief overview of the procurement of design services, different procurement procedures (national and European) and the rules of legal protection for public procurement are explained from the perspective of the client and contractor for construction services, and a possible transferability to privately financed projects is discussed. Sustainability requirements for design and construction processes are also addressed. Considerations are also given on how to draft a contract that fully describes the performance objective and all the rights and obligations of the contracting parties.

BIM-based Acquisition of Construction Projects (Role-Playing Game): The interactive and hands-on course presents and practises the essential steps of a tendering process. Students are divided into several teams and compete as (virtual) construction companies for a construction contract. The preparation of a tender based on a given specification is supported by the Building Information Modelling (BIM) methodology, after the basics of the methodology and the necessary software have been presented in self-developed tutorials. The construction companies and their indicative bids are presented by the respective teams to the potential clients (IBBs) in face-to-face meetings. In a second face-to-face meeting, additional information has to be integrated and the binding offers have to be negotiated in terms of financial and legal conditions before the contract is awarded to the best construction company.

Objective qualification

Students will acquire in-depth knowledge of the design of tender processes and specifications by the client, and of cost estimation and pricing by the contractor. Students will be familiar with the objectives and methods of costing as a planning task, as well as cost and performance accounting under the responsibility of executing companies. Different forms of planner and contractor deployment and remuneration models are considered. This will enable students to differentiate between the planner's or project manager's perspective (cost planning) and the contractor's perspective (cost accounting) and to understand the specific characteristics of each project phase. Students will also be able to take into account the constraints and specifications for the implementation of public sector projects and the specific implications for the tendering and

awarding process and the drafting of contracts. In this context, students will also learn about the opportunities and consequences of integrating specific environmental and social requirements, including the importance of supply chains. Alternatively, students can either take the perspective of a construction company in a planning and role-playing exercise, and then use BIM methodology to actively accompany a procurement process in construction projects with regard to calculating the bid price and negotiating the legal framework.
Literature

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german
	2,0	Lecture/Exercise	german
	2,0	Lecture	german

Title	Organisation and Management of Construction and Business Processes		
Number	4321080	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Bauwirtschaft und Baubetrieb
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Patrick Schwerdtner
Workload (h)	180		
Class attendance (h)	84	**Self studying (h)**	96
Compulsory requirements			
Expected performance/ Type of examination	Written exam (60 min) or Exam (30 min)		
Course achievement			
Examination language	german		

Contents

Construction Business Management:
The course presents and practises the three levels of business management and explores them in depth in a variety of scenarios with current references. While normative management explains the development of a vision and mission as well as the development of a corporate culture and corresponding goals, strategic management deals with fundamental questions and methods of strategy development as well as strategic tools. Operational management focuses on organisation and process management. Finally, problem-solving methods are presented.

Construction Site Management:
The course focuses on the typical responsibilities and tasks of construction management from the perspective of a contractor. The topics covered are based on the phases of construction management activities. Firstly, there are the preparatory considerations with clarification of the performance target and the agreed remuneration, as well as the project team and other parties involved. This is followed by the start-up phase, which involves scheduling and the procurement of goods and services. During implementation, processes need to be monitored and controlled for quality, time and cost. In this context, lean construction management methods are also presented. In the event of changes, the handling of additional offers and agreements is shown - accompanied by explanations on communication and documentation.

Private Construction and Architectural Law:
Contractual agreements form the basis for the provision of services in the course of the implementation of construction projects. After an explanation of the main features of public construction law and private construction contracts, special features of general terms and conditions are presented. This is followed by a discussion of the contractor's right to remuneration, distinguishing between contracts governed by the German Civil Code (BGB) and contracts governed by the German Construction Contract Procedures (VOB/B). This distinction also applies to the treatment of warranty rights, with acceptance being of particular importance and therefore treated separately. As further aspects of contract design and implementation, security and penalty clauses are also dealt with separately.

Objective qualification

Upon completion of the module, students will be able to take on company or site-specific management tasks in technical, organisational and economic terms for simple and medium-sized projects. On the one hand, students will learn to differentiate between the different perspectives and responsibilities of the client and contractor in the management of construction projects. On the other hand, students are familiarised with the different levels of construction management and learn how to use strategic tools and problem-solving methods. The structure of the courses takes into account the content previously developed in other modules, so that students have a particular systemic understanding. Alternatively, students will acquire legal skills for drafting and implementing contracts based on the provisions of the German Civil Code (BGB) and the German Construction Contract Procedures (VOB) for assessing the resulting rights and obligations or claims.
Literature

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german
	2,0	Lecture/Exercise	german
	2,0	Lecture	german

Title	Project Management in Waterways Engineering		
Number	4398790	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	2	**Institution**	Abteilung Wasserbau und Gewässermorphologie
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Jochen Aberle
Workload (h)	180		
Class attendance (h)	72	**Self studying (h)**	108
Compulsory requirements			
Expected performance/ Type of examination	3 Examinations: 2 Written exams (each 60 Min.) or 1 Written exam (60 Min.) and 1 oral exam (15 Min.) and a presentation		
Course achievement			
Examination language	german		

Contents

[Inland Waterways Engineering (VÜ)]
Inland navigation; administration of the federal waterways; canals and inland vessels; dynamics of inland vessels; river training; sluices

[Project Management in Waterways Engineering (V)]
Planning and implementation of projects in waterways engineering; responsibilities; planning stages; scheduling and resource planning; tenders and tender models; risk management; consideration of interest groups; process optimization options

Objective qualification

Projektmanagement im Bauwesen kann entweder im Modul Realisierung und Finanzierung oder im Modul Projektmanagement im Verkehrswasserbau eingebracht werden.
The students acquire in-depth knowledge of inland navigation, the required waterway engineering infrastructure and project management for the construction, maintenance and rehabilitation of infrastructure elements from the point of view of the waterways and shipping administration. They will be able to understand the functionality of hydraulic structures used in waterways engineering and to design hydraulically these structures. They will gain in-depth insights into the methods and tools that can be used in waterways engineering projects and how such projects can be carried out in a goal-oriented manner from an organizational, legal, technical, economic and scheduling point of view.

Literature

Präsentationsfolien der Vorlesungen

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german
	2,0	Seminar	german
	2,0	Lecture/Exercise	german

Title	Vibrations		
Number	2540110	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät für Maschinen-bau
Module duration	1	**Institution**	Institut für Akustik und Dynamik
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Michael Müller
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Expected performance/ Type of examina-tion	1 Examination element: written exam (90 min) or oral exam (30 min)		
Course achievement			
Examination language	german		

Contents

- Linear / non-linear vibrations
- phase portrait
- self-excited vibrations
- limit cycle
- Fourier approximation
- linear vibrations with time-dependent coefficients
- Poincaré mapping
- chaotic vibrations

Objective qualification

The students apply different forms of description for the characterization of linear and especially non-linear vibrations. They are able to analyse vibration systems with regard to their mathematical properties and to evaluate them with regard to their stability. On the basis of analogies, students can transfer the knowledge derived from systems with few degrees of freedom to real systems. The students can apply the numerical methods for the description of non-linear oscillations to new examples.

Literature

- K. Magnus, K. Popp, Schwingungen, B. G. Teubner, 1997
- S. Landa, Regular and Chaotic Oszillations, Springer, 2001
- P. Hagedorn, Nichtlineare Schwingungen, Akad. Verl.-Ges., 1978 Verlagsgesellschaft

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
	1,0	Exercise	german

Title	Morphology of the City		
Number	2497440	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Nachhaltigen Städtebau
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Vanessa Carlow
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Examination language	german		
Contents			
Objective qualification			
Literature			
Literatur zu den Themen: Bücherliste, Buchbesprechungen Unterlagen zu den Übungen			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Seminar	german
	4,0	Seminar	german

Title	City and Society		
Number	3307000010	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Bauklimatik und Energie der Architektur
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Henriette Bertram
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Examination language	german		
Contents			
Objective qualification			
Literature			
Wird zu Beginn des jeweiligen Semesters bekannt gegeben			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	4,0	Lecture/Exercise	german

Title	Road design and UAV-based topographic mapping		
Number	4398560	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	
Module duration	2	**Institution**	Institut für Straßenwesen
Hours per Week / ECTS	6 / 6,0	**Module owner**	Prof. Dr. Michael Wistuba
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Examination language	german		
Contents			
Objective qualification			
Literature			
-Reinhardt: Öffentlicher Personennahverkehr -Pachl: Systemtechnik des Schienenverkehrs -Naumann: Leit- und Sicherungstechnik im Bahnbetrieb			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture/Exercise	german
	2,0	Exercise	german
	2,0	Lecture/Exercise	german

Title	Systemic Principles of Construction Project Delivery		
Number	4321020	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	
Module duration	1	**Institution**	Institut für Bauwirtschaft und Baubetrieb
Hours per Week / ECTS	4 / 6,0	**Module owner**	Prof. Dr. Patrick Schwerdtner
Workload (h)	180		
Class attendance (h)	56	**Self studying (h)**	124
Compulsory requirements			
Expected performance/ Type of examination	Written Exam (120 min) or oral exam (20 min)		
Course achievement			
Examination language	german		

Contents

Developments and Mechanisms in the Construction:
Industry First, the characteristics of the construction market and construction production are explained and justified on the basis of the specific structures of the construction market. Responsibilities and interfaces are discussed in more detail on the basis of different roles, focusing on the respective contribution of different actors to the planning and implementation of construction production. In this context, the role of the public sector in the implementation of construction projects as a commissioning and licensing authority is also examined in more detail. The specific current and future challenges of the construction industry will be addressed in particular through selected aspects of the three dimensions of sustainability and the philosophy of lean management. Based on this, the basic requirements for the planning and execution process will be derived from contractual and regulatory constraints as a starting point for further courses and modules.

Project Delivery Systems:
At the start of a project, in the initiation phase, essential constraints and requirements are defined. Building on this, the German construction market offers various guiding principles for project management. These are presented with their specific characteristics - supplemented by insights into international models - and examined from different perspectives. From the unit-price contract with sole proprietors to the general contractor and partnering model to integrated project management, responsibilities, rights and obligations are defined and the appropriate projects or project types are assessed. The focus is on assessing opportunities and risks through early integration of execution expertise into the planning process and the importance of collaboration between project stakeholders. Particular attention is paid to the remuneration model, risk allocation and dispute resolution procedures.

Objective qualification

Students will have an in-depth knowledge of the structures of the construction industry and the organisation of planning and execution processes. They will be familiar with the basic requirements for the implementation of construction projects based on the demands of particular interests and social or regulatory expectations for the sustainability of construction production. Particular attention will be paid to explaining the interaction of the various participants against the background of their respective responsibilities for the preparation and implementation of the construction production process, so that students are enabled to think in their respective roles and to recognise the emerging interfaces. In this context, students will be able to iden-

tify suitable models of project management in construction from different perspectives and evaluate their impact on responsibilities and opportunities for efficient and goal-oriented implementation of the planning and execution phases. Due to the range of models presented, students will be familiar with both conventional models and alternative models of project management based on increased levels of collaboration.
Literature

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
	2,0	Lecture	german
	2,0	Lecture/Exercise	german

Title	Technical Safety		
Number	2539310	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the winter term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für Akustik und Dynamik
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Sabine Langer
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Recommended requirements	The Technical Reliability Module (MB-VuA-10) is recommended as a prerequisite.		
Expected performance/ Type of examination	1 Examination element: written exam, 90 minutes or oral exam, 30 minutes		
Course achievement			
Examination language	german		

Contents

The lecture #technical safety# is acquisition of knowledge of the fundamentals of safety engineering, the methodology of safety analysis and risk assessment. The knowledge will be transferred with the following contents: - Fundamentals of safety analysis - Fundamentals of risk assessment - Industrial-sector-specific measures - Preliminary/potential hazard analysis (PHA) - Failure mode, effects, and criticality analysis (FMECA) - Other safety analysis and risk assessment methods - Probabilistic safety analysis resp. probabilistic risk assessment - Safety plan and safety case.

Objective qualification

After the completion of the module, students will be able to link the knowledge about safety-related system development, gained by examples of real applications, on safeguarding technical systems on a constructive and normative level. This familiarity with the normative framework for the certification of technical systems and the associated principles and institutions enables the students to describe and discuss the process cascade of designing, testing and certification of technical systems. Students can determine the hazard posed by technical systems by selecting and applying the methods and means of description relevant in the normatively described processes. By acquiring basic knowledge of the functional and constructional principles of safe devices, equipment, installations and systems, students are able to assess and qualify such systems with regard to their safety relevance. They can assess the effectiveness of safety architectures for hardware and software systems considering suitable examples. Furthermore, students are able to evaluate the safety management of companies and institutions based on selected criteria.

Literature

VDI: Qualitätsmerkmal: Technische Sicherheit
Dhillon Meyna, Pauli: Taschenbuch der Zuverlässigkeit und Sicherheit, Hanser-Verlag
Schnieder, E.: Verkehrssicherheit, Springer, 2011
IEC 61508: Funktionale Sicherheit sicherheitsbezogener elektrischer/ elektronischer/ programmierbarer elektronischer Systeme

DIN EN 50126: Bahnanwendungen - Spezifikation und Nachweis von Zuverlässigkeit, Verfügbarkeit, Instandhaltbarkeit und Sicherheit (RAMS) - Leveson, N.: Safeware # System Safety and Computers, Addison-Wesley 1995 Peter Wratil und Michael Kieviet: Sicherheitstechnik für Komponenten und Systeme, ISBN 9783800732760
Remark
The content of the lecture is close to the VDI 4002 Part 2 standard, which is developed for the education of reliability engineers. Furthermore, the contents of the module build on the foundations of reliability engineering.

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	3,0	Lecture/Exercise	german

Title	Reliability Engineering		
Number	2539100	**Module version**	
Shorttext		**Language**	german
Frequency of offer	only in the summer term	**Teaching unit**	Fakultät für Maschinenbau
Module duration	1	**Institution**	Institut für Akustik und Dynamik
Hours per Week / ECTS	3 / 5,0	**Module owner**	Prof. Dr. Sabine Langer
Workload (h)	150		
Class attendance (h)	42	**Self studying (h)**	108
Compulsory requirements			
Recommended requirements	No special qualifications are required for the participation in this module.		
Expected performance/ Type of examination	1 Examination element: written exam, 90 minutes or oral exam, 30 minutes		
Course achievement			
Examination language	german		

Contents

- Reliability terminology
- concepts and rules of probability theory
- statistical reliability measures
- lifetime and state distribution functions
- system reliability
- Markov chains
- maintainability

Objective qualification

After having completed the module, students will be able to derive system reliability models based on common means of description, methods and tools as well as making reliability design decisions based on those models. The students can formulate and name elementary definitions of reliability, probability theory, important distribution functions of component states and life times as well as statistical measures used in system reliability. Furthermore, students are able to calculate probabilities for determining the reliability of single/multi-component systems. On the basis of case studies, they can evaluate the effects of reliability assessment, fault-tolerant structures as well as reserve and maintenance strategies. Moreover, they can apply Markov chains to incorporate the aspects of maintenance into these computations. The students understand the different concepts of maintainability on the basis of selected examples.

Literature

- Bertsche, Bernd; Lechner, Gisbert; Zuverlässigkeit im Fahrzeug- und Maschinenbau - Ermittlung von Bauteil- und System-Zuverlässigkeiten Springer-Verlag, 2004
- Meyna, A.; Pauli, B.; Taschenbuch der Zuverlässigkeits-und Sicherheitstechnik, Hanser, 2003
- Ericson, Clifton A.; Hazard Analysis Techniques for System Safety, Wiley & Sons, 2005

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**
	2,0	Lecture	german
Literature			
Skript mit ca. 120 Seiten Ergänzende Literatur wird zu Beginn der Vorlesung vorgeschlagen.			
	1,0	Exercise	german

Professionalisation

Title			
Number	3497360	**Module version**	
Shorttext		**Language**	
Frequency of offer		**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration		**Institution**	
Hours per Week / ECTS	/ 8,0	**Module owner**	
Workload (h)			
Class attendance (h)		**Self studying (h)**	
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Examination language			
Contents			
Objective qualification			
Literature			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**

Title			
Number	2497320	**Module version**	
Shorttext		**Language**	
Frequency of offer	every term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration		**Institution**	
Hours per Week / ECTS	/ 2,0	**Module owner**	
Workload (h)	60		
Class attendance (h)		**Self studying (h)**	60
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Examination language			
Contents			
Objective qualification			
Literature			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**

Title	Study Project		
Number	4310810	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	1	**Institution**	
Hours per Week / ECTS	0 / 6,0	**Module owner**	
Workload (h)	180		
Class attendance (h)	1	**Self studying (h)**	180
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Examination language	german		
Contents			
Objective qualification			
Literature			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**

Title	Master's Thesis		
Number	4399360	**Module version**	
Shorttext		**Language**	german
Frequency of offer	every term	**Teaching unit**	Fakultät Architektur, Bauingenieurwesen und Umweltwissenschaften
Module duration	1	**Institution**	
Hours per Week / ECTS	0 / 20,0	**Module owner**	
Workload (h)			
Class attendance (h)		**Self studying (h)**	600
Compulsory requirements			
Expected performance/ Type of examination			
Course achievement			
Examination language	german		
Contents			
Objective qualification			
Literature			
abhängig von der konkreten Aufgabenstellung			

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Related courses			
Rules for the choice of courses			
Compulsory attendance			
Name of the course	**SWS**	**Eventtype**	**Language**