Module manual for
Computer Science
BSInf

SPO Version 2022
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Module manual for Computer Science (Bachelor (1-Subject))

Module manual for
Computer Science
BSInf

RWTH AACHEN UNIVERSITY

Examination Regulation Field

Module offer

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Module manual for
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BSInf

RWTH AACHEN UNIVERSITY

Examination Regulation Title & Version: Computer Science (SPO Version / 2022)

Title	Computer Science
Short title	BSInf
Version	2022
Study/Qualification Objectives	A graduated Bachelor student in Computer Science understands the foundations of computer science (theories, concepts, methods, and techniques), is able to work at different levels of abstraction including the hard- and software level, and has a systematic approach characterized by the development and use of theories, models, and coherent implementations. Students are taught to critically reflect on their own thinking, decision making, and actions, and adjust these based on their reflections. They have creativity and decent skills with regard to design problems in computer science and have the competence to increase and develop their knowledge and skills through further studies on their own. Another focus is the competence in co-operating (oral and written) communication, and acquiring a professional attitude characterized by independence, commitment, drive, reliability, and accuracy. Based on this profile, graduated Bachelor students can either be directly employed in the IT sector or continue with a master's program. They are prepared to rapidly familiarize themselves with existing and new IT systems and technologies. The Bachelor program Computer Science at RWTH Aachen University offers a broad spectrum of education in the scientific foundations of Computer Science. Graduates of the program have developed competences in designing, analyzing, and implementing information-processing systems and their components. The program prepares for subsequent master programs as well as for direct employment in the information technology sector. The program is structured in four computer science related fields and an application subject: • Practical Computer Science: Students learn the basics and different concepts of programming, fundamental algorithms, and data structures, as well as software engineering methods and concepts. They reinforce and apply their skills in a software development project. Additionally, students learn the concepts of database systems as well as their application. • Technical Computer Science: Students get to know different computer architectures and their key elements as well as the underlying basics in electrical engineering. Moreover, they learn the concepts of operating system development and apply the theory in a practical lab course on operating system development for a micro-controller platform. Additionally, students learn the basics of communication systems, Internet protocols, and related security issues. • Theoretical Computer Science: Students get to know the theoretical foundation of computer science. They learn to understand and work with discrete mathematical structures, formal systems, automata models, and formal process representations. Furthermore, they study the concepts and major results of computability and complexity theory and mathematical logic. • Mathematics: Students attend introductory courses at university level mathematics, which is used throughout the different fields of computer science. These courses include analysis, linear algebra, statistics, probability theory, and numerical analysis. • Application subjects: Students follow an application subject to broaden their scientific spectrum and see possible applications of computer science in other fields. Among others the following application subjects are offered: Business Administration, Electrical Engineering, Mathematics, Biology, Physics, Mechanical Engineering, Medicine, and Philosophy. In addition to the compulsory courses, the students take four elective courses focusing on advanced topics of computer science. In these courses, the students see and develop applications of the principles and concepts learned at the beginning of their studies. A course typically requires the weekly completion of exercises, and at least 50 percent of these exercises need to be successfully completed to qualify for participation in the (written or oral) exam of the respective course. The students finish their studies with an independently written bachelor’s thesis. They solve on their own a part of a research question under the supervision of an experienced scientist. Finally, they write down their results in a scientific report and present it to the research group and other students. The entire study program Bachelor Computer Science consists of 180 ECTS credits.
Qualification Profile	

Additionnal information

+ Programming Concepts (1214957)

Module titel	Programming Concepts (Compulsory subject)
Identifier	1214957
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor

Content	• formal languages (grammars and syntax diagrams)
	• introductory imperative programming concepts
	  ◦ basic data types
	  ◦ control structures (sequences, conditionals, loops, etc.)
	  ◦ functions and procedures
	• introductory object-oriented programming concepts
	  ◦ objects, classes, methods
	;
	• advanced imperative programming concepts
	  ◦ foundations of program verification
	  ◦ pointers, side effects, and foundations of memory management
	  ◦ paradigms for parameter passing (call-by-value, call-by-reference)
	  ◦ recursive (linear) data structures (e.g., lists, stacks, queues, etc.)
	  ◦ basic classical programs (e.g., basic search and sorting algorithms)
	• advanced object-oriented programming concepts
	  ◦ polymorphism, dynamic binding
	  ◦ abstract classes and interfaces
	  ◦ programming techniques in imperative and object-oriented languages (e.g., data abstraction, modularization, application programmer interface, etc.)
	• functional programming concepts
	  ◦ declarations, expressions, pattern matching, evaluation strategies (call-by-value, call-by-name)
	  ◦ type concepts and polymorphism
	  ◦ basic higher-order functions
	• logic programming concepts
	  ◦ facts and rules
	  ◦ unification and solving queries

Learning Objectives/ Learning Outcomes	Knowledge: ;After successful completion of the module students know • essential concepts of imperative and object-oriented programming languages as well as important programming techniques in these languages • basics of memory management in imperative and object-oriented programming languages • different semantics for variables, references and parameter passing • programming concepts of logical and functional programming languages • basic data structures and their formulation in different programming paradigms • basic description forms for programming languages • the procedure for program verification Skills: ;After successful completion of the module, students will be able to • Apply programming techniques of imperative and object-oriented programming languages • Apply programming techniques of logical and functional programming languages • Implement data structures in various programming paradigms • Interpret basic description forms for programming languages • Perform program verification in simple Java programs

+ Programming Concepts (1214957)

	Competencies: ;Based on the knowledge and skills acquired in the module, students will be able to • independently develop small programs • test programs for correctness • document ;; appropriately • comply with programming conventions
(Study-Specific) Prerequisites	None.
(recommended) Requirements	None.
References	Folien und Skripte zur Vorlesung sowie z.B. folgende Bücher: • K. Echtle, M. Goedicke: ;Lehrbuch der Programmierung mit Java, dpunkt Verlag, 2000 • R. Bird: ;Introduction to Functional Programming Using Haskell, Prentice Hall, 1998 • W. F. Clocksin, C. S. Mellish: ;Programming in Prolog, Springer, 2003
Language	German
Examination Terms	Written Exam (100 %). Students must pass written homework and an in-person exercise to be admitted to the examination.
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. ir. Dr. h. c. (AAU) Joost-Pieter Katoen &; Universitätsprofessor Dr.-Ing. Ulrik Schroeder &; Universitätsprofessor Dr. rer. nat. Jürgen Giesl
ECTS Credits	8
Contact time (WSH)	6
Examination duration (min)	-
Total hours (h)	240,0
Contact hours (h)	90,0
Self-study hours (h)	150,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Programming Exercises (121495702)	1st semester	no semester recommended	0	0.5
Exam Programming (121495701)	1st semester	no semester recommended	8	0

+ Programming Concepts (1214957)

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Programming	1st semester	no semester recommended	-	1
Global Exercise Programming	1st semester	no semester recommended	-	-

+ Data Structures and Algorithms (1211971)

Module titel	Data Structures and Algorithms (Compulsory subject)
Identifier	1211971
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor
Content	Complexity of algorithms • Models for running time and memory space • Worst case und average case analysis • Asymptotic complexity (O-notation) • Complexity categories (e.g., exponential, polynomial) General design and analysis concepts like • Greedy algorithms • Divide and conquer • Dynamic programming • Heuristic approaches (especially, branch and bound) • Recurrence equations (master theorem) Algorithms for sorting problems • Simple algorithms like insertion sort • More advanced algorithms like merge, quick, and heap sort • Lower bound for comparison based sorting algorithms • Key based sorting (e.g., bucket sort) • Order statistics (especially, quick select) Data structures for managing sets • Linear data structures • Binary search trees • Balanced search trees • Priority queues • Hashing Graph and network algorithms • Depth/breadth first search • Shortest path • Minimum spanning tree • Matchings and flows Algorithmic Geometry, e.g., • Sweepline technique • Nearest neighbours Other selected topics
Learning Objectives/ Learning Outcomes	Knowledge: After successful completion of the module, students know • basic design methods for algorithms • essential complexity categories for runtime and memory requirements of algorithms • efficient algorithms and data structures for standard problems Skills: After successful completion of the module, students will be able to • apply basic methods for runtime analysis of algorithms • formally model algorithmic problems • adapt existing algorithms and data structures to a given problem Competencies: Based on the knowledge and skills acquired in the module, students will be able to • design new algorithms and data structures for solving relevant problems, prove their correctness and analyze their complexity

+ Data Structures and Algorithms (1211971)

(Study-Specific) Prerequisites	None.
(recommended) Requirements	Knowledge about the essential programming concepts and techniques of imperative and object oriented programming languages (Lecture Programming). Knowledge about linear data structures like arrays, lists, and stacks (Lecture Programming).
References	Folien und Skripte zur Vorlesung sowie z.B. folgende Bücher: • T. Cormen, C. Leiserson, R. Rivest, C. Stein: Introduction to Algorithms, 2nd Edition, MIT Press and McGraw-Hill, 2001. • K. Mehlhorn and S. Näher: The LEDA Platform of Combinatorial and Geometric Computing, Cambridge University Press, 1999. • T. Ottmann, P. Widmayer: Algorithmen und Datenstrukturen, 4. Auflage, Spektrum Akademischer Verlag, 2002. • R Sedgewick: Algorithms, 2nd Edition, Addison-Wesley, 2002.
Language	German
Examination Terms	Written Exam (100 %). Students must successfully complete the module component "Python für OO/Java-Programmierer:innen" and pass written homework to be admitted to the examination.
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. rer. nat. Leif Kobbelt &; Universitätsprofessor Dr. ir. Dr. h. c. (AAU) Joost-Pieter Katoen &; Universitätsprofessor Dr.-Ing. Hermann Ney &; Universitätsprofessor Dr. rer. nat. Peter Rossmanith
ECTS Credits	7
Contact time (WSH)	6
Examination duration (min)	0
Total hours (h)	210,0
Contact hours (h)	90,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercises Data Structures and Algorithms (121197102)	2nd semester	no semester recommended	0	2
Exam Data Structures and Algorithms (121197101)	2nd semester	no semester recommended	7	0

+ Data Structures and Algorithms (1211971)

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Data Structure and Algorithms (2)	2nd semester	no semester recommended	-	4
Global Exercise Data Structures and Algorithms (2)	2nd semester	no semester recommended	-	-

+ Software Engineering (1211965)

Module titel	Software Engineering (Compulsory subject)
Identifier	1211965
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	This lecture provides an introduction to foundations of the development of complex software systems. It deals with development processes, requirements engineering, software architecture and design, ways towards implementation and towards quality assurance by means of testing. Notations are primarily introduced in the modeling language UML. • Introduction, basic terms • Activities and documents in the development life cycle • The development and maintenance process • Problem analysis and requirements engineering • Design and modeling of architectures, architectural patterns • Design patterns • Quality assurance • Project management • Documentation • Tool demo: MontiWeb
Learning Objectives/ Learning Outcomes	Knowledge: After successful completion of the module, students know • the software development process and its domain-specific variants • process models for software development as well as their phases • models and modeling languages for development activities • tools in the software development process • agile methods • software architectures and variant software Skills: After successful completion of the module, students will be able to • characterize software development processes • use process models for projects • apply techniques for quality assurance • develop models at different levels of abstraction • develop and execute tests • use tools in the software development process • classify legal regulations for development and product Competencies: Based on the knowledge and skills acquired in the module, students will be able to • systematically conduct software development for smaller and medium-sized tasks in a team, based on the division of labor and taking quality criteria into account, using suitable tools or structure projects with more complex boundary conditions
(Study-Specific) Prerequisites	None.
(recommended) Requirements	For the understanding of this course, knowledge from the lectures "Programmierung", "Einführung in die Technische Informatik", "Datenstrukturen und Algorithmen" is required. This lecture can also be taken by eager students as part of a minor subject.

+ Software Engineering (1211965)

References	• H. Lichter, J. Ludewig: Software Engineering: Grundlagen, Menschen, Prozesse, Techniken<; • I.Sommerville: Software Engineering, Pearson Studium • H.Balzert: Lehrbuch der Software-Technik, Band 1, Spektrum Akademischer Verlag
Language	German
Examination Terms	Written Exam (100 %). Students must successfully complete the module component "Werkzeuge und -Methoden fürs Software Entwickeln" and pass written homework to be admitted to the examination.
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Modulangebotsverantwortlicher Informatik Modellierungsteamverantwortlicher: Dr. rer. nat. Katja Petzoldt Modulverantworlicher: Universitätsprofessor Dr. rer. nat. Bernhard Rumpe
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	0
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercises Introduction to Software Engineering (121196502)	3rd semester	no semester recommended	0	2
Exam Introduction to Software Engineering (121196501)	3rd semester	no semester recommended	6	0

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Introduction to Software Engineering	3rd semester	no semester recommended	-	3
Global Exercise Software Engineering	3rd semester	no semester recommended	-	-

+ Databases and Information Systems (1211969)

Module titel	Databases and Information Systems (Compulsory subject)
Identifier	1211969
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	• Roles and importance of information systems • Relational Database Models • Relational query languages and their formal foundations • Design of relational databases (conceptual modelling, normalisation theory) • Foundations of the implementation of relational database systems (architectures, query processing, transaction management) • Overview of advanced data models - object-oriented and object-relational data models - Internet information systems / XML - Information modelling in enterprises / ERP systems • Practical exercises in the database lab: SQL-Day, XML-Day, ERP-Day
Learning Objectives/ Learning Outcomes	Knowledge: After successful completion of the module students know • the design of operational information systems • the role of databases and information systems • the relational database model, in particular the relational query languages (SQL) and their formal foundations • the approach to relational database design, in particular conceptual modeling and normalization theory • basic problems and approaches of database implementation and database administration (architecture, query evaluation, transaction management) • basic problems and approaches of database implementation and database administration (architecture, query evaluation, transaction management) • semi-structured data models • fundamentals of data engineering Skills: After successful completion of the module, students will be able to • develop queries to relational databases (SQL) • systematically design relational databases, in particular perform their conceptual modeling, translation into a database schema, and normalization • implement and administer databases (architecture, query evaluation, transaction management) • design operational information systems • apply principles of data engineering Competencies: Based on the knowledge and skills acquired in the module, students will be able to • design and implement business information systems based on relational database technology for given problems • create a conceptual model of a domain, transform it into a database schema and then implement the database schema in a database • store data based on the database schema and query it in SQL • use alternative data models such as XML and RDF and query them • to handle tools of data engineering

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+ Databases and Information Systems (1211969)

(Study-Specific) Prerequisites	Completed module Mentoring in Informatics
(recommended) Requirements	Data Structures and Algorithms Foundations of Logic.
References	- Folien zur Vorlesung - Standardbücher: • Elmasri R., Navathe S.B., Fundamentals of Database Systems Benjamin-Cummings • Kemper, A., Eicker, A.: Datenbanksysteme – eine Einführung. Oldenbourg. Seite 10 • Vossen G., Datenmodelle, Datenbanksprachen und Datenbank-Managementsysteme, Addison-Wesley
Language	German
Examination Terms	Written Exam (100 %). Students must pass written homework to be admitted to the examination.
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. rer. pol. Stefan Decker &; Universitätsprofessor Dr. rer. pol. Matthias Jarke
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	0
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercises Databases and Information Systems (121196902)	4th semester	no semester recommended	0	2
Exam Databases and Information Systems (121196901)	4th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Databases and Information Systems (2)	4th semester	no semester recommended	-	3
Global Exercises Databases and Information Systems (2)	4th semester	no semester recommended	-	-

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+ Elements of Machine Learning and Data Science (1226970)

Module titel	Elements of Machine Learning and Data Science (Compulsory subject)
Identifier	1226970
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2024
Valid until	-
Module level	Bachelor
Content	Introduction • Overview of the broader Data Science, Machine Learning, Artificial Intelligence space. • Brief introduction to symbolic AI • Introduction to standard ML paradigms: supervised learning, unsupervised learning, reinforcement learning • Commonly encountered data and preprocessing: time-series, images, video Foundations • Selective Review of Probability: common univariate and multivariate distributions • Selective Review of Statistics: Maximum Likelihood estimation, Empirical Risk Minimization, Regularization, Bayesian vs Frequentist statistics • Selective Review of Linear Algebra and Optimization: singular valud decomposition, spectral decomposition, gradient methods • Decision Theory: Classification problems, ROC curves, Regression problems, Hypothesis Testing, Cross-validation and Model Selection Linear Models • Linear Discriminant Analysis: Gaussian Discriminant Analysis, Naive Bayes, Generative vs. discriminative classifiers • Logistic Regression: binary logistic regression, multinomial logistic regression • Linear Regression: Least Squares, Ridge Regression, LASSO Non-parametric Models • Classification and Regression Trees and Forests • Bagging and Boosting • Kernel methods and Support Vector machines Unsupervised Learning • Dimensionality reduction (PCA, MDS) • Clustering (k-means and Gaussian Mixtures, spectral clustering) A shallow Introduction to Deep Networks • Perceptron and Multi-layer perceptron • Training DNN with backpropagation
Learning Objectives/ Learning Outcomes	Knowledge: After successful completion of the module students know • the general topics considered in artificial intelligence (considered in a broad sense) • standard methods, models and concepts in Data Science and Machine Learning and their mathematical underpinnings • some of the main limitations of standard machine learning procedures such as over-fitting Skills: After successful completion of the module, students will be able to • understand, analyse and implement standard machine learning algorithms. This includes methods based on linear models (e.g., regression, logistic regression), standard non-linear models (classification trees, kernel methods, support vector machines), and basic unsupervised learning techniques (dimensionality reduction, clustering).

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+ Elements of Machine Learning and Data Science (1226970)

	• understand the basics of neural networks and how they can be trained Competencies: Based on the knowledge and skills acquired in the module, students will be able to • abstract tasks as machine learning problems and select and implement appropriate methods for their solution • assess the quality of the solution
(Study-Specific) Prerequisites	Completed module "Mentoring in Informatics" (1214959)
(recommended) Requirements	None.
References	-
Language	English
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the examination.
Miscellaneous	-
Module coordinator	-
ECTS Credits	6
Contact time (WSH)	3
Examination duration (min)	-
Total hours (h)	180,0
Contact hours (h)	45,0
Self-study hours (h)	135,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Elements of Machine Learning and Data Science (122697001)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture/Exercise Elements of Machine Learning and Data Science	5th semester	no semester recommended	-	3

+ Introduction to Computer Engineering (1214958)

Module titel	Introduction to Computer Engineering (Compulsory subject)
Identifier	1214958
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	• Refreshment of basic knowledge in physics (charge, Field, potential, voltage, current, resistance, Ohm laws, potential divider, Kirchhoff laws, capacity, capacitor, charging function, RC low-pass-filter, induction, RLC resonant circuit) • Semiconductor components (pn-junction, diod, characteristic curve, applications: rectifier, AND/OR-gates, Bipolar transistor, characteristiccurve, physical illustration (npn, pnp), applications: switch, FlipFlop) • Hardware design (introduction to schematics and VHDL, compositionof simple sequential circuit (e.g. Automata or ALU) in VHDL) • Microcontroller (architecture, interrupts, programming,application) • Specific combinatorial circuits and how to improve them • Computational arithmetic • Von-Neumann architecture, CISC/RISC
Learning Objectives/ Learning Outcomes	Knowledge: After successful completion of the module, students will know • the physical principles underlying the operation of electronic computers • the main technologies and concepts required in the design and analysis of computer-based systems • the structure and operation of digital computers and their parts, and the mathematical tools used to describe and design them. • ;(Knowledge to perform the systems programming lab). Skills: Upon successful completion of the module, students will be able to • ; ; ; use electronic components • ; ; ; implement basic circuits • ; ; ; apply basic skills in hardware design Competencies: Based on the knowledge and skills acquired in the module, students will be able to, • ; ; ; communicate competently with engineers
(Study-Specific) Prerequisites	None.
(recommended) Requirements	None.
References	s. Veranstaltung im CAMPUS
Language	German
Examination Terms	Written Exam (100 %). Students must pass written homework to be admitted to the examination.

+ Introduction to Computer Engineering (1214958)

Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Modulangebotsverantwortlicher InformatikModellierungsteamverantwortlicher: Dr. rer. nat. Katja PetzoldtModulverantworlicher: Universitätsprofessor Dr.-Ing. Stefan KowalewskiUniversitätsprofessor Gerhard Lakemeyer Ph. D.
ECTS Credits	6
Contact time (WSH)	6
Examination duration (min)	0
Total hours (h)	180,0
Contact hours (h)	90,0
Self-study hours (h)	90,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercises Introduction to Computer Engineering (121495802)	1st semester	no semester recommended	0	2
Exam Introduction to Computer Engineering (121495801)	1st semester	no semester recommended	6	0

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Introduction to Computer Engineering	1st semester	no semester recommended	-	4

+ Operating Systems and System Software (1214960)

Module titel	Operating Systems and System Software (Compulsory subject)
Identifier	1214960
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor
Content	• Tasks and Structure of Operating Systems • The Operating System Unix • System Calls and Shell Programming • Introduction to the C Programming Language • Process Management: Processes, Threads, and Inter-Process Communication • Synchronization of Processes, Concurrency, and Deadlocks • CPU Scheduling • Memory Management: Segmentation, Paging, Fragmentation, Virtual Memory • Stack and Heap Management, Garbage Collection • File System and Access Control • I/O System • Distributed Systems • Network Programming with Sockets
Learning Objectives/ Learning Outcomes	Knowledge: Upon successful completion of the module, students will know. • basic concepts of the structure of operating systems • basic concepts of the interaction of the components of a computer • the interaction between hardware and software Skills: Upon successful completion of the module, students will be able to. • independently use shell utilities to utilize operating system functionality. • implement operating system functionality in the C programming language • manage operating systems Competencies: Based on the knowledge and skills acquired in the module, students will be able to, • consider operating system characteristics during implementation and selection. • use provided functionality of an operating system also in the professional environment
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Contents of the Lecture/Exercises Technical Computer Science.
References	• A. Silberschatz, G. Gagne, P. B. Galvin: Operating System Concepts. 9th Edition, Wiley, 2013 • A. S. Tanenbaum: Modern Operating Systems. 4th Edition, Prentice Hall, 2014. • O. Spaniol: Systemprogrammierung - Skript zur Vorlesung an der RWTH Aachen. Aachener Beiträge zur Informatik, Band 14. 3. Auflage, Mainz-Verlag, 2002. • Folien zur Vorlesung / Lecture Slides
Language	German/English

+ Operating Systems and System Software (1214960)

Examination Terms	The module examination consists of the following partial qualifications: Weekly Programming Assignments (20 %); written exam (80 %). Students must successfully complete the module component "C- und Shellprogrammierung" and pass written homework to be admitted to the examination.
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. Redha Gouicem
ECTS Credits	7
Contact time (WSH)	5
Examination duration (min)	0
Total hours (h)	210,0
Contact hours (h)	75,0
Self-study hours (h)	135,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercises Operating Systems and System Software (121496002)	2nd semester	no semester recommended	0	2
Exam Operating Systems and System Software (121496003)	2nd semester	no semester recommended	6	0

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Operating Systems and System Software (2)	2nd semester	no semester recommended	-	3
Global Exercise Operating Systems and System Software (2)	2nd semester	no semester recommended	-	0

+ System Programming (1211967)

Module titel	System Programming (Compulsory subject)
Identifier	1211967
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor
Content	The lab course System Programming introduces central topics of hardware oriented programming. At the end of this course participants have developed a simple operating system written in the programming language C and based on a simple microcontroller. During the development participants will learn about electrical basics in computer science, signal processing, and typical issues of hardware programming like interrupts, limited hardware resources, or integrated functionalities of microcontrollers. Refreshing basic knowledge in physics, handling of measurement devices; Microcontroller (architecture, programming, applications); Scheduler, interrupts and polling, memory and memory management; Activating additional hardware like external devices; Connection to peripheral devices like A/D-converters; Analog devices - Signal processing and environment.
Learning Objectives/ Learning Outcomes	Knowledge: Upon successful completion of the module, students will know. • physical principles underlying the operation of electronic computers • concepts and procedures for the development of hardware-related software Skills: Upon successful completion of the module, students will be able to. • deal with the C programming language in interaction with hardware • use and implement basic functionalities of an operating system, taking hardware into account • manage resources efficiently in hardware-related environments. Competencies: Based on the knowledge and skills acquired in the module, students will be able to, • communicate competently in a professional environment with engineers • independently solve tasks in a team and present results
(Study-Specific) Prerequisites	The module requires the successful completion of module "Introduction to Computer Engineering".
(recommended) Requirements	Knowledge of programming, operating systems, system software and computer engineering.
References	Practical Lab course materials of the Chair of Computer Science 11; script of the Chair of Computer Science 4 for the lecture System Programming; A. Silberschatz, P. Galvin: Operating System Concepts, 4th Edition Addison-Wesley; A. S. Tanenbaum: Operating Systems, Design and Implementation, Prentice-Hall; F. Vahid, T. Givargis: Embedded System Design, John Wiley &; Sons; J. Catsoulis: Embedded Hardware, O'Reilly; W. Schiffmann, R. Schmitz: Technische Informatik 1, Springer; W. Schiffmann: Technische Informatik 2, Springer; M. Barr: Programming embedded systems in C and C++, O'Reilly.
Language	German
Examination Terms	Practical training (100 %). Attendance in the practical lab is mandatory.

+ System Programming (1211967)

Miscellaneous	-
Module coordinator	Universitätsprofessor Dr.-Ing. Stefan Kowalewski
ECTS Credits	8
Contact time (WSH)	3
Examination duration (min)	-
Total hours (h)	240,0
Contact hours (h)	45,0
Self-study hours (h)	195,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lab Course System Programming (121196701)	3rd semester	no semester recommended	8	3

+ Data Communication (1211972)

Module titel	Data Communication (Compulsory subject)
Identifier	1211972
Version	V3
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2022
Valid until	-
Module level	Bachelor/Master
Content	• Client/Server and Peer-to-Peer Systems • OSI Reference Model and TCP/IP Reference Model • Communication Media and Signal Representation • Error Handling, Flow Control and Medium Access • Local Area Networks, especially Ethernet • Network Components and Firewalls • Internet Protocols: IP, Routing, TCP/UDP • Security Management and Data Protection, Security Problems and Attacks in the Internet • Basics of Cryptography and Secure Internet Protocols
Learning Objectives/ Learning Outcomes	Knowledge: Upon successful completion of the module, students will know. • the structure of communication protocols • protocols and components in local networks • common Internet protocols as well as possible attack scenarios and security problems Skills: Upon successful completion of the module, students will be able to. • use common Internet protocols • use protocols and components in local networks • implement simple applications that communicate over Internet protocols. Competencies: Based on the knowledge and skills acquired in the module, students will be able to, • independently design the structure of local area networks • assess the benefits of using specific Internet protocols • fundamentally assess security problems
(Study-Specific) Prerequisites	-
(recommended) Requirements	Content of the lecture "Operating Systems and System Software"
References	• A. S. Tanenbaum: Computer Networks, 4th Edition, Prentice-Hall International, 2003 • J. F. Kurose, K. W. Ross: Computer Networking - A Top-Down Approach, 5th Edition, Pearson, 2010 • C. Kaufman, R. Perlman, M. Speciner, Network Security - Private Communication in a Public World, 2nd Edition, Prentice Hall PTR, 2002 • Zus?tzlich: Folien zur Vorlesung
Language	German
Examination Terms	Written exam (100%). Students must pass written homework to be admitted to the module examination.

+ Data Communication (1211972)

Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Modulangebotsverantwortlicher Informatik Modellierungsteamverantwortlicher: Sebastiaan Wouters Modulverantworlicher: Universitätsprofessor Dr.-Ing. Klaus Wehrle
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	-
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercises Data Communication (121197202)	3rd semester	no semester recommended	0	2
Exam Data Communication (121197201)	3rd semester	no semester recommended	6	0

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Data Communication (2)	3rd semester	no semester recommended	-	3
Global Exercise Data Communication (2)	3rd semester	no semester recommended	-	-

+ IT-Security (1226971)

Module titel	IT-Security (Compulsory subject)
Identifier	1226971
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2024
Valid until	-
Module level	Bachelor
Content	In particular the course will convey the following content • Basic terminology used in IT-Security • Selected attacks on current networked systems and their causes • Basic principles of applied cryptography including symmetric and asymmetric encryption, symmetric integrity protection with message authentication codes, asymmetric integrity protection with digital signatures • Protocols for authentication and key agreement • Basics of network security, especially firewall concepts and practical protocols for network security, as well as availability attacks and their countermeasures. • Basics of system security, especially characteristics of malware, vulnerabilities and infection routes used by malware, possible countermeasures • Basic privacy protection measure
Learning Objectives/ Learning Outcomes	Knowledge: After successful completion of the module students know • basic concepts, methods, and protocols to protect the confidentiality and integrity of data as well as the availability of systems and services • the origin of security problems of current networked systems Skills: After successful completion of the module, students will be able to • describe the interrelationship between protection mechanisms on the algorithmic or protocol level on the one hand and the security problems they address on the other hand and are to transfer this knowledge to new use cases
(Study-Specific) Prerequisites	Completed module Mentoring in Informatics
(recommended) Requirements	Discrete Mathematics, Data Communication, Operating Systems
References	-
Language	English
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the examination.
Miscellaneous	-
Module coordinator	-
ECTS Credits	4
Contact time (WSH)	3

+ IT-Security (1226971)

Examination duration (min)	-
Total hours (h)	120,0
Contact hours (h)	45,0
Self-study hours (h)	75,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam IT-Security (122697101)	5th semester	no semester recommended	4	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture/Exercise IT-Security	5th semester	no semester recommended	-	3

RWTH AACHEN UNIVERSITY

+ Formal Systems, Automata, Processes (1214961)

Module titel	Formal Systems, Automata, Processes (Compulsory subject)
Identifier	1214961
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	1. Formal Systems: Terms, words, and languages as foundational concepts, introduced by representative examples (number expressions, arithmetic and Boolean expressions, while programs). Definition of languages by rule systems (term rewrite systems, grammars), derivation relations, method of structural induction. Classification of grammars (Chomsky hierarchy) and elementary facts about context-free grammars (normal forms, word problem (derivability test), non-emptiness problem). 2. Automata: Finite automata (deterministic and non-deterministic), closure properties (using product automata), regular expressions, non-emptiness and equivalence problem, proof of non-regularity of languages. Pushdown automata (deterministic and non-deterministic), translation of context-free grammars into pushdown automata as an example of implementing recursion by pushdown stores. 3. Processes: Foundational models of distributed and concurrent systems: example-oriented introduction of synchronized automata products, Petri nets, and Communicating Sequential Processes (CSP). Comparison with basic finite-automata model.
Learning Objectives/ Learning Outcomes	Knowledge: After successful completion of the module students know • finite automata and regular expressions • context-free grammars and pushdown automata • regular and context-free languages • concurrency models Skills: After successful completion of the module students will be able to • apply fundamental algorithms to finite automata and determine the computational complexity of the algorithms • investigate and use formal languages with different tools • analyze concurrent systems Competencies: Based on the knowledge and skills acquired in the module, students will be able to • transfer the learned contents to application areas such as compiler construction and verification • use formal models of computer science in a mathematically sound way
(Study-Specific) Prerequisites	None.
(recommended) Requirements	None
References	Skript und Folien zur Vorlesung Standardbücher: • Hopcroft, Motwani, Ullman, Introducton to Automata, Theory, Languages, and Computation, Addison-Wesley 2001 (Ch.1-7)

+ Formal Systems, Automata, Processes (1214961)

	• M. Sipser, Introduction to the Theory of Computation, PWS Publ. Comp. 1997, Part 1.
Language	German
Examination Terms	Written Exam (100 %). Students must pass written homework to be admitted to the examination.
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Modulangebotsverantwortlicher InformatikModellierungsteamverantwortlicher: Dr. rer. nat. Katja PetzoldtModulverantworlicher: Universitätsprofessor Dr. ir. Dr. h. c. (AAU) Joost-Pieter KatoenUniversitätsprofessor Dr. rer. nat. Martin GroheUniversitätsprofessor Dr. rer. nat. Jürgen GieslUniversitätsprofessor Dr. rer. nat. Peter Rossmanith
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	0
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercises Formal Systems, Automata, Processes (121496102)	2nd semester	no semester recommended	0	2
Exam Formal Systems, Automata, Processes (121496101)	2nd semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Formal Systems, Automata, Processes (2)	2nd semester	no semester recommended	-	3
Global Exercise Formal Systems, Automata, Processes (2)	2nd semester	no semester recommended	-	0

+ Computability and Complexity (1212004)

Module titel	Computability and Complexity (Compulsory subject)
Identifier	1212004
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	• Examples of algorithmic problems, their representation as languages and functions, problem of solvability • Turing machines, Church-Turing-Thesis • Computability, decidability, enumerability • Simulations between different models of computation, universal machines and programs • Undecidable problems (e.g., Post Correspondence Problem) • Complexity classes and basics on time and space complexity • Polynomial time reductions and NP-completeness • Approximation as an approach to NP-hard problems, example of a polynomial time approximation scheme
Learning Objectives/ Learning Outcomes	Knowledge: After successful completion of the module students know • the basic computational models of a Turing machine and RAM • the notion of undecidability for computational problems • important examples of undecidability • the notion of Turing power • the concept of primitive recursive functions • important complexity classes of computer science • polynomial reductions and NP-completeness • important examples of NP-complete problems Skills: After successful completion of the module students will be able to • formally define Turing machines for basic algorithms • distinguish between problems that are computable/enumerable and those that are not • perform undecidability proofs • recognize primitive recursive functions • classify problems into complexity classes • create and analyze polynomial reductions Competencies: Based on the knowledge and skills acquired in the module, students will be able to • evaluate the decidability of an algorithmic problem • determine and evaluate the computational complexity of an algorithmic problem • relate the theory of computability to the theory of computational complexity and other areas of computer science
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Knowledge of the modules 'Discrete Structures' and 'Formal Systems, Automata, Processes'.
References	• Skript und Folien zur Vorlesung

+ Computability and Complexity (1212004)

Language	German
Examination Terms	Written Exam (100 %). Students must pass written homework to be admitted to the examination.
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Modulangebotsverantwortlicher InformatikModellierungsteamverantwortlicher: Dr. rer. nat. Katja PetzoldtModulverantworlicher: Universitätsprofessor Dr. ir. Dr. h. c. (AAU) Joost-Pieter KatoenUniversitätsprofessor Dr. rer. nat. Martin GroheUniversitätsprofessor Dr. rer. nat. Peter RossmanithUniversitätsprofessor Dr. rer. nat. Jürgen Giesl
ECTS Credits	7
Contact time (WSH)	5
Examination duration (min)	0
Total hours (h)	210,0
Contact hours (h)	75,0
Self-study hours (h)	135,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercises Computability and Complexity (121200402)	3rd semester	no semester recommended	0	2
Exam Computability and Complexity (121200401)	3rd semester	no semester recommended	7	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Computability and Complexity	3rd semester	no semester recommended	-	3
Global Exercise Computability and Complexity	3rd semester	no semester recommended	-	-

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+ Mathematical Logic I (1113004)

Module titel	Mathematical Logic I (Compulsory subject)
Identifier	1113004
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor
Content	Aussagenlogik: Grundlagen, algorithmische Fragen, Endlichkeits- und Vollständigkeitssatz Prädikatenlogik der 1.~Stufe: Strukturen, Syntax und Semantik der Logik der 1. Stufe, Modellierung in der Logik der 1. Stufe und Anwendungsbeispiele, Beweiskalküle, Termstrukturen, Endlichkeits- und Vollständigkeitssatz, algorithmische Fragen und Unentscheidbarkeit Ausblick auf weitere logische Systeme
Learning Objectives/ Learning Outcomes	Kenntnisse: Grundlegende Begriffe und Methoden der mathematischen Logik, fundamentale Resultate der mathematischen Logik. Fähigkeiten: Anwendung der Methoden der mathematischen Logik in verschiedenen Szenarien; die Fähigkeit, Ausdrucksstärke und Grenzen logischer Systeme beurteilen können; die Fähigkeit, die algorithmische Fragen zu formalen Systemen einschätzen und mit geeigneten Methoden bearbeiten zu können. Kompetenzen: Logischen Modellierung und der exakte Entwurf logischer Systeme, der Umgang mit mathematischen Techniken zur Analyse formaler Systeme.
(Study-Specific) Prerequisites	Completed module Mentoring in Informatics
(recommended) Requirements	Mathematische Grundlagen den Bereichen Lineare Algebra, Analysis und diskrete Mathematik (beispielsweise die Vorlesungen "Lineare Algebra 1" oder "Lineare Algebra für Informatiker", "Analysis 1" oder "Analysis für Informatiker", "Diskrete Strukturen"); Grundlagen der theoretischen Informatik (beispielsweise die Vorlesungen "Formale Systeme, Automaten und Prozesse" und "Berechenbarkeit und Komplexität").
References	H.-D. Ebbinghaus, J. Flum, W. Thomas, Einführung in die mathematische Logik, 6. Aufl., Springer Verlag 2018.
Language	German
Examination Terms	Written Exam (100 %). Students must pass written homework to be admitted to the examination.
Miscellaneous	-
Module coordinator	Univ.-Prof. Dr. rer. nat. Martin Grohe
ECTS Credits	7

RWTH AACHEN UNIVERSITY

+ Mathematical Logic I (1113004)

Contact time (WSH)	5
Examination duration (min)	-
Total hours (h)	210,0
Contact hours (h)	75,0
Self-study hours (h)	135,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Mathematical Logic I (111300402)	4th semester	no semester recommended	0	2
Exam Mathematical Logic I (111300401)	4th semester	no semester recommended	7	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Mathematical Logic I (2)	4th semester	no semester recommended	-	3

+ Discrete Structures (1115472)

Module titel	Discrete Structures (Compulsory subject)
Identifier	1115472
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor
Content	• Sets, functions, relations on the basis of examples from computer science • Boolean algebra • Finite combinatorics • Elementary number theory • Fields and polynomial rings • Matrix arithmetic, solution techniques for systems of linear equations • Elementary graph theory
Learning Objectives/ Learning Outcomes	Knowledge: • General mathematical notions, e.g. sets, maps, relations • Standard examples of fundamental algebraic notions, e.g., group, ring, field, polynomial • Formulas and methods of elementary combinatorics, including binomial coefficients and Stirling numbers • Graphs and graph algorithms • Solution techniques for systems of linear equations • Matrix arithmetic skills: • Logical deduction • Producing simple mathematical proofs • Combinatorial calculations • Performing graph algorithms • Systematic solving of systems of linear equations Competences: • Understanding of mathematical expressions and terminology • Independent study and comprehension of elementary mathematics texts • Ability to abstract
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Keine
References	A. Steger, Diskrete Strukturen, Bd.1, Springer 2001.
Language	German
Examination Terms	Zulassungsvoraussetzung: Lösen von Übungsaufgaben Klausur oder mündliche Prüfung. Die Modulnote ist die Note der Klausur bzw. die Note der mündlichen Prüfung
Miscellaneous	-

+ Discrete Structures (1115472)

Module coordinator	Universitätsprofessor Dr. rer. nat. Gerhard Hiß
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	-
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercises Discrete Structures (111547202)	1st semester	no semester recommended	0	2
Examination Discrete Structures (111547201)	1st semester	no semester recommended	6	0

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Discrete Structures	1st semester	no semester recommended	-	3

RWTH AACHEN UNIVERSITY

+ Calculus for Computer Science (1114971)

Module titel	Calculus for Computer Science (Compulsory subject)
Identifier	1114971
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor
Content	1. Real numbers 2. Sequences of real numbers 3. Functions of real numbers 4. Differentiation 5. Integration (Riemann-integral) 6. Series of real numbers 7. Sequences and series of functions 8. Improper integrals 9. Functions of several variables
Learning Objectives/ Learning Outcomes	• Understanding of the basics in calculus, such as limits,continuity, differentiation and integration. • The ability of applying fundamental techniques from calculus. • Development of the mathematical way of thinking (from intuition up to precise mathematical concepts) • Development of mathematical analysis in basic areas, such as the solution of nonlinear equations (iterative methods and feedback idea). • Training in solving problems on examination level.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	None
References	H. Esser und H. Th. Jongen, Analysis für Informatiker, Skript
Language	German
Examination Terms	Admission Requirements: Completing Exercises The grade of the module results 100% from the final written module exam. If homework throughout the semester is taken into account for the module grading, then the examination regulations need to be considered. Exam after the end of the lecture period.
Miscellaneous	-
Module coordinator	-
ECTS Credits	8
Contact time (WSH)	6
Examination duration (min)	-
Total hours (h)	240,0

+ Calculus for Computer Science (1114971)

Contact hours (h)	90,0
Self-study hours (h)	150,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercises Calculus for Computer Science (111497102)	1st semester	no semester recommended	0	2
Exam Calculus for Computer Science (111497101)	1st semester	no semester recommended	8	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Calculus for Computer Science	1st semester	no semester recommended	-	4
Global Exercise Calculus for Computer Science	1st semester	no semester recommended	-	-

+ Linear Algebra (1115861)

Module titel	Linear Algebra (Compulsory subject)
Identifier	1115861
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor
Content	• linear maps and matrices; • linear systems of equations (solution sets, over- and underdetermined systems, Gaussian elimination, LU decomposition, inverses and pseudo-inverses); • determinants; • eigenvalues and eigenvectors; • diagonalization; • bilinear and quadratic forms; • scalar products; • orthogonality; • Gram-Schmidt orthogonalization; • QR decomposition; • singular value decomposition; • spectral theorems; • discrete Fourier transform
Learning Objectives/ Learning Outcomes	• understanding of linear structures; • development of mathematical intuition and geometric perception; • knowledge of algebraic structures in terms of examples; • insight into applications of linear algebra to selected problems; • basic understanding of numerical aspects
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Keine
References	• G. Fischer, Lineare Algebra, Vieweg, 2000 • K. Jänich, Lineare Algebra, Springer, 2001 • S. Lang, Lineare Algebra, 3rd Ed., Springer, 1989 • F. Lorenz, Lineare Algebra I, Spektrum, 1992 • C. Meyer, Matrix Analysis and Applied Linear Algebra, Wellesley-Cambridge Press, 2003 • L. Trefethen, D. Bau, Numerical Linear Algebra, SIAM, 1997
Language	German
Examination Terms	Zulassungsvoraussetzung: Lösen von Übungsaufgaben Die Benotung ergibt sich zu 100% aus der abschließenden schriftlichen Prüfung zum Modul. Wird vorgesehen, dass semesterbegleitende Hausaufgaben auf die Prüfungsnote angerechnet werden, sind die entsprechenden Regelungen der Prüfungsordnung zu beachten. Prüfung nach Ende der Vorlesungszeit.
Miscellaneous	-

+ Linear Algebra (1115861)

Module coordinator	-
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	-
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Linear Algebra (111586101)	2nd semester	no semester recommended	6	0
Exercises Linear Algebra (111586102)	2nd semester	no semester recommended	0	2

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Linear Algebra (2)	2nd semester	no semester recommended	-	3

Introduction to Applied Stochastics (1112712)

Module titel	Introduction to Applied Stochastics (Compulsory subject)
Identifier	1112712
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor
Content	1. Introduction 2. Probability - a. Probability space • Basics of Probability (Sets, Axioms of Kolmogorov, Laplace Model, Fundamentals of Combinatorics) • Discrete Probability Measures (Binomial Distribution, Poisson Distribution, Geometric Distribution,...) • Properties of Probability Measures • Conditional Probabilities • Stochastic Independence of Events • Probability Measures with Riemann Densities (Uniform, Exponential, Weibull, Gamma, Normal Distribution,...) - b. Random Variables • Random Variables and Probability Measures • Probability Density Function, Cumulative Distribution Function and Quantile Function • Random Vectors (Joint Distribution, Multivariate Normal Distribution, Marginal and Conditional Distribution, Product Spaces) • Transformation of Random Variables (Density Transformation, Convolution) • Expected Values, Variance, Covariance and Correlation • Generating Functions and Laplace Transform • Conditional Expectation 3. Statistics - a.Basic Methods of Descriptive Statistics • Introduction and Terms • Measures of Location and Scale • Empirical Distribution Function • Grouped Data and Histogram • Measures of Association • Regression Analysis - b. Elementary Methods in Statistical Inference • Problems in Statistical Inference • Point Estimation (Unbiasedness, Best Estimation, Consistency) • Estimation of Distribution Functions • Maximum Likelihood Estimation • Confidence Intervals • Estimation with Normal Distributions • Central Limit Theorem • Linear Regression • Elements of Bayesian Statistics (Bayesian Decision Theory, Parameter and Confidence Estimation, Estimation of Probabilities)
Learning Objectives/ Learning Outcomes	Development of statistical thinking and ability to use statistical terms correctly. Understanding of basic ideas of Probability and Statistics. Ability to employ models and methods presented. Knowledge of basic tools to be used in further studies.
(Study-Specific) Prerequisites	Completed module Mentoring in Informatics
(recommended) Requirements	Keine

+ Introduction to Applied Stochastics (1112712)

References	• Skript zur VL, Standardbücher
Language	German
Examination Terms	Zulassungsvoraussetzung: Lösen von Übungsaufgaben Die Benotung ergibt sich zu 100% aus der abschließenden schriftlichen Prüfung zum Modul. Wird vorgesehen, dass semesterbegleitende Hausaufgaben auf die Prüfungsnote angerechnet werden, sind die entsprechenden Regelungen der Prüfungsordnung zu beachten. Prüfung nach Ende der Vorlesungszeit.
Miscellaneous	-
Module coordinator	-
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	-
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Introduction to Applied Stochastics (111271202)	4th semester	no semester recommended	0	1
Exam Introduction to Applied Stochastics (111271201)	4th semester	no semester recommended	6	0

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Introduction to Applied Stochastics (2)	4th semester	no semester recommended	-	3
Tutorial Introduction to Applied Stochastics	4th semester	no semester recommended	-	2

+ Mentoring in Informatics (1214959)

Module titel	Mentoring in Informatics (Compulsory subject)
Identifier	1214959
Version	V2
Duration (Semester)	two semesters
Cycle (Semester)	winter/summer semester
Valid from	Summer semester 2018
Valid until	-
Module level	Bachelor
Content	The content of the Computer Science Mentoring Programme is divided into the following sections and comprises irregularly alternating lectures, small group meetings and one-on-one interviews. Organization Study: Introduction to the systems, registrations, tools; Structure of the university: student parliament, AStA, student council, university institutions; Preparation of a written examination plan, learning in groups; Efficient learning: Different forms and their usefulness; Occupation computer scientist: Requirements, ideas compared to reality; Research areas computer science: Current topics and future developments.
Learning Objectives/ Learning Outcomes	Acquisition of the following knowledge and skills for successful participation in everyday university life in computer science: Ability to independently find one's way around the organisational process of studying computer science on the basis of given information; this includes in particular the organisation of registrations for examinations and exercise groups as well as independent planning and evaluation of the course of studies. Ability to participate in political debates by applying the knowledge acquired about the university's political structure and the department's structure and to evaluate internal university processes such as votes, discussions and elections. Ability to evaluate one's own learning strategies, to reflect on them and to actively solve problems in one's own learning processes through one's own actions, mentoring discussions or student training. Ability to assess the profession of computer scientist and the research area of computer science and to draw conclusions about one's own planning of the course of study, in particular compulsory elective subjects and the choice of modules in the area of applied courses ;and a later career choice.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	None.
References	-
Language	German
Examination Terms	The module is passed if one attends the mentoring of the first semester and passes two of the compulsory examinations of the first semester in the semester of the first attendance; or attends the mentoring of the first and second semester. Attendance at mentoring events is mandatory (max. two missed dates).
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. rer. nat. Uwe Naumann
ECTS Credits	1
Contact time (WSH)	2
Examination duration (min)	-

+ Mentoring in Informatics (1214959)

Total hours (h)	30,0
Contact hours (h)	30,0
Self-study hours (h)	,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Mentoring in Informatics (121495901)	1st semester	no semester recommended	1	2
Mentoring (121495902)	2nd semester	no semester recommended	0	0
Mentoring in Informatics (121495903)	1st semester	no semester recommended	1	2

+ Introduction to Scientific Working (Proseminar Computer Science) ...

Module titel	Introduction to Scientific Working (Proseminar Computer Science) (Compulsory subject)
Identifier	1211968
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor
Content	The educational objective here is reached by practice on personally assigned topics from computer science, as well as active participation in the presentation meetings. The areas of the topics to be assigned are chosen by the respective instructor offering the proseminar.
Learning Objectives/ Learning Outcomes	Acquisition of the following knowledge and skills to be able to present concepts and methods of computer science scientifically: Methods of literature research in physical and electronic scientific libraries. The ability to introduce oneself independently into a given topic of computer science by selecting and treating appropriate references (Training by the computer science library personnel based on individually matched literature research examples). Ability to create a written report on a given topic from computer science with clarity and reasonable formalisms, within a given time frame and of a defined length; proper attention to citation techniques; proof of independent development by presentation of appropriate self-selected examples. Ability plan and carry out a vivid oral presentation of a topic from computer science using appropriate media and examples within a given time frame. Ability to participate actively in discussions on topics of computer science in courses with compulsory attendance. Where appropriate, ability to achieve a group decision on the division of a theme into several sub-themes and their allocation to the participants.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Basic knowledge of computer science from modules of the 1st or 2nd semester (depending on the concrete topic).
References	Topic-dependent; is specified or researched by the student. Wissenschaftliches Arbeiten in der Informatik: https://moodle.rwth-aachen.de/course/view.php?id=19034
Language	German
Examination Terms	Written homework and presentation (100 %). Attendance in the seminar is mandatory.
Miscellaneous	-
Module coordinator	Fachgruppe Informatik
ECTS Credits	4
Contact time (WSH)	3
Examination duration (min)	-
Total hours (h)	120,0

+ Introduction to Scientific Working (Proseminar Computer Science) ...

Contact hours (h)	45,0
Self-study hours (h)	75,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Introduction to Scientific Working (Proseminar Computer Science) (121196801)	2nd semester	no semester recommended	4	2

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Introduction to Scientific Working (2)	2nd semester	no semester recommended	-	1

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+ Software Project Lab (1211973)

Module titel	Software Project Lab (Compulsory subject)
Identifier	1211973
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor
Content	Participants acquire, in particular, knowledge of group dynamics related to division of labor. (a required work product is late or missing, participants need to be 'motivated' to deliver a work product, etc.). These effects of group dynamics will come up because every group will have to manage division of labor itself. Moreover, coordination and presentation are practiced. Presentation of work results is done in groups and plenum to improve presentation skills.
Learning Objectives/ Learning Outcomes	The software project lab focuses on teaching established knowledge of software development. This is done by developing a software system comprising several components. Hence, participants are required to learn a (new) programming language and to apply it in detail. Moreover, participants learn how to use state of the art development tools and how to document and present own work results. Lastly, participants validate their results systematically by software reviews and software tests. In a nutshell, participants will figure out that a solution can only be achieved in case interfaces are planned, described and followed accurately.
(Study-Specific) Prerequisites	Completed module Mentoring in Informatics
(recommended) Requirements	Knowledge of programming, software engineering, data structures, algorithms and system programming.
References	Will be announced in future.
Language	German
Examination Terms	Practical training (100 %). Attendance in the practical lab is mandatory.
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. rer. nat. Horst Lichter & Fachgruppe Informatik
ECTS Credits	6
Contact time (WSH)	3
Examination duration (min)	-
Total hours (h)	180,0
Contact hours (h)	45,0
Self-study hours (h)	135,0

+ Software Project Lab (1211973)

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Software Project Lab (121197301)	4th semester	no semester recommended	6	3

+ Seminar Computer Science (1211974)

Module titel	Seminar Computer Science (Compulsory subject)
Identifier	1211974
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor
Content	The educational objective here is reached by practice on personally assigned specialized topics from computer science, as well as active participation in the presentation meetings. The areas of the topics to be assigned are chosen by the respective instructor offering the proseminar.
Learning Objectives/ Learning Outcomes	Acquisition of the following knowledge and skills to be able to treat and present concepts, methods, and results of a scientific topic from computer science appropriately: Ability to treat a specialized topic from computer science independently on the basis of appropriate references, especially scientific original articles, to classify the topic appropriately, to narrow the topic down, and to develop a critical evaluation. Ability to create a comprehensive written report on a given special topic from computer science with clarity and reasonable formalisms, within a given time frame and of a defined length; proof of independent development by presentation of appropriate self-selected examples. Ability plan and carry out a vivid oral presentation of a specialized topic from computer science using appropriate media and examples within a given time frame. Ability to participate actively in discussions on special topics of computer science in courses with compulsory attendance.
(Study-Specific) Prerequisites	The module requires the successful completion of module "Introduction to Scientific Working (Proseminar Computer Science)".
(recommended) Requirements	None.
References	Topic-dependent; is specified or researched by the student.
Language	German
Examination Terms	Written homework and presentation (100 %). Attendance in the seminar is mandatory.
Miscellaneous	-
Module coordinator	Fachgruppe Informatik
ECTS Credits	4
Contact time (WSH)	2
Examination duration (min)	-
Total hours (h)	120,0
Contact hours (h)	30,0
Self-study hours (h)	90,0

+ Seminar Computer Science (1211974)

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Seminar (121197401)	5th semester	no semester recommended	4	2

Non-Technical Elective Module
Public Speaking and Conversation Skills (7014625)

Module titel	Public Speaking and Conversation Skills (Compulsory elective subject)
Identifier	7014625
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor
Content	Im Plenum werden grundlegende, studientypische und anwendungsspezifische Strukturen und Prozesse der rhetorischen Kommunikation beschrieben, interpretiert und fachgeschichtlich reflektiert. Unter starkem Praxisbezug werden die wesentlichen Inhalte ausgewählter Teilgebiete der Rhetorik (z.B. Rede und Präsentation, Gespräch, Moderation und Debatte, Argumentation) dargestellt. Im Übungsseminar werden elementare Prinzipien der Wahrnehmung und Beurteilung kommunikativen Handelns vermittelt und erlebbar gemacht. Anhand unterschiedlicher Redearten und Gesprächstypen werden eigene kommunikative Leistungen individuell und auf Basis des in der Vorlesung erworbenen Wissens analysiert und optimiert. Die Übungen bieten darüber hinaus die Möglichkeit, Techniken des Feedbacks und der unterstützenden Personenkritik anzuwenden.
Learning Objectives/ Learning Outcomes	Ziel des Moduls ist es, den Studierenden Strukturen, Methoden und Prozesse der sprechsprachlichen Kommunikation unter berufsspezifischer Sicht zu vermitteln. Die Studierenden beherrschen die für ein geistes- und gesellschaftswissenschaftliches Studium notwendigen sprechsprachlichen Kommunikationsformen: Referat und Diskussion. Dabei sind den Studierenden elementare rede- und gesprächsrhetorische sowie sprecherzieherische Aspekte dieser Kommunikationsformen vertraut. Sie sind darüber hinaus in der Lage, kommunikatives Verhalten wahrzunehmen, zu analysieren und situationsangemessen zu variieren.
(Study-Specific) Prerequisites	-
(recommended) Requirements	-
References	-
Language	German
Examination Terms	Das Übungsseminar ‘Rede- und Gesprächsrhetorik’ ist gemäß § 6 anwesenheitspflichtig. 90-minütige Klausur im Plenum Rede- und Gesprächsrhetorik 10-minütiger Prüfungsvortrag zum Übungsseminar ; Die Modulnote setzt sich zusammen aus den nach CP gewichteten Noten der Klausur und des Prüfungsvortrags.
Miscellaneous	-
Module coordinator	• Modulangebotsorganisatorin: Vanessa Ziemons M.A., lema@fb7.rwth-aachen.de • Modellierungsverantwortlich: Modellierungsteam (Abt. 1.5), modellierungsteam@zhv.rwth-aachen.de • Modulverantwortlicher: Björn Meißner
ECTS Credits	6
Contact time (WSH)	4

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– Non-Technical Elective Module
+ Public Speaking and Conversation Skills (7014625)

Examination duration (min)	100
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Public Speaking and Conversation Skills - Plenum (701462501)	5th semester	no semester recommended	4	0
Public Speaking and Conversation Skills - Seminar (701462502)	5th semester	no semester recommended	2	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Plenum: Rede- und Gesprächsrhetorik	5th semester	no semester recommended	-	2
Übungsseminar: Rede- und Gesprächsrhetorik	5th semester	no semester recommended	-	2

Non-Technical Elective Module
Bookkeeping and Managerial Accounting (8014709)

Module titel	Bookkeeping and Managerial Accounting (Compulsory elective subject)
Identifier	8014709
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2023
Valid until	-
Module level	Bachelor/Master
Content	Teil "Buchführung": • Zwecke und Zielgrößen der Finanzberichte von Unternehmen, • System der doppelten Buchführung, • Behandlung von relevanten Ereignissen während des Abrechnungszeitraums, • Behandlung von relevanten Ereignissen am Ende des Abrechnungszeitraums • Abschlussarbeiten Teil "internes Rechnungswesen": • Einführende Fallstudie • Problematik von Erlös- und Kostenrechnungen • Kostenartenrechnungen, • Kostenstellenrechnungen, • Kostenträgerrechnungen, • Anwendung von Erlös- und Kostenträgerrechnungen in verschiedenen Entscheidungssituationen, • Planungsrechnungen und Abweichungsermittlung
Learning Objectives/ Learning Outcomes	Nach erfolgreichem Absolvieren der Veranstaltung sollen Studierende die Grundlagen von Buchführung und internem Rechnungswesen verstanden haben und anwenden können. Im einzelnen sollen Studierende: Wissen/ Verstehen: a) Buchführungssystem und Buchführungsprozess verstanden haben, b) die grundlegenden Finanzberichte von Unternehmen kennen und wissen, wie diese aus Daten der Buchführung herzuleiten sind, c) wissen wie diese Daten im Rahmen eines internen Rechnungswesens in unternehmerische Entscheidungen einbezogen werden können. Fähigkeiten: a) Buchführung betreiben können und Methoden bzw. Verfahren des internen Rechnungswesens beherrschen, b) in die Lage versetzt werden, mittels des internen Rechnungswesens unternehmerische Entscheidungen zu fundieren. Durch die Veranstaltung sollen die Studierenden folgende Kompetenzen erwerben:

	- Wissen und Fähigkeit zur Anwendung wirtschaftlicher Methoden und Theorien - Kritisches Hinterfragen von wirtschaftlichen Problemstellungen - Quantitative Methoden und angewandte Lösungsverfahren.
(Study-Specific) Prerequisites	-
(recommended) Requirements	None
References	Möller, H.P., Hüfner, B., Ketteniß, H.: Buchführung und Finanzberichte, 5., Auflage, Wiesbaden (SpringerGabler) 2018. Friedl, G., Hofmann, C., Pedell, B.: Kostenrechnung ? Eine entscheidungsorientierte Einführung, 3. Auflage München (Vahlen) 2017. Möller, H.-P., Hüfner, B., Ketteniß, H.: Internes Rechnungswesen, 2. Auflage, Heidelberg et al. (Springer) 2010.
Language	German
Examination Terms	1. Modulbaustein als Prüfungsvoraussetzung (verpflichtend): Voraussetzung für die Zulassung zur Prüfung ist das Bestehen von Hausaufgaben, 2. Klausur (100%, benotet, 70min.) 3. Modulbaustein (freiwillig): Möglichkeit zur Notenverbesserung der Note der regulären Prüfung um 0,3 bzw. 0,4 Notenpunkte durch erfolgreiches Absolvieren von online-Hausaufgaben
Miscellaneous	-
Module coordinator	Dr. rer. pol. Claudia Nadler
ECTS Credits	4
Contact time (WSH)	4
Examination duration (min)	70
Total hours (h)	120,0
Contact hours (h)	60,0
Self-study hours (h)	60,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Bookkeeping and Managerial Accounting (Exam) (801470901)	5th semester	no semester recommended	4	0
Bookkeeping and Managerial Accounting (Module Component) (801470902)	5th semester	no semester recommended	0	0

Non-Technical Elective Module
Bookkeeping and Managerial Accounting (8014709)

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Bookkeeping and Managerial Accounting (Lecture)	5th semester	no semester recommended	-	2
Bookkeeping and Managerial Accounting (Exercise)	5th semester	no semester recommended	-	2

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– Non-Technical Elective Module
+ Civil Law (7022978)

Module titel	Civil Law (Compulsory elective subject)
Identifier	7022978
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Summer semester 2021
Valid until	-
Module level	Master
Content	Aufbau der Rechtsordnung in Haupt- und Nebenrechtsgebiete; Tatbestand und Rechtsfolge bei Rechtsnormen, Subsumieren, Auslegung und Verständnis von Vorschriften Aufbau/Struktur des BGB; Haftung aus Verträgen: Vertragsschluss durch Willenserklärung, Formvorschriften bei Verträgen, Schutz der Minderjährigen, Vertretung bei Vertragsabschluss, §§ 164 ff. BGB, Verbraucherschutzrechte insbesondere Widerruf bei Außergeschäftsraum und Fernabsatzverträgen; Gewährleistung bei Kauf-/Werkverträgen, Haftung bei Dienstverträgen und gesetzliche Haftung für unerlaubte Handlungen, §§ 823 ff. BGB Recht des selbstständigen Unternehmens: Haftung juristischer Personen und Handelsgesellschaften, Recht der Kaufleute nach dem Handelsgesetzbuch, Kreditsicherung Grundlagen Arbeitsrecht, Kündigungsschutzrecht, Gleichbehandlung von Arbeitnehmern, Rechte der freien Mitarbeiter in Unternehmen Grundlagen Strafrecht, Voraussetzung einer Strafbarkeit, Aufgaben von Polizei und Staatsanwaltschaft, Rechte der Beschuldigten Gesetzgebungskompetenz im Medienrecht, Schutz von Presse und Meinungsfreiheit im Grundgesetz, Schutz der Persönlichkeit in der Berichterstattung, Sorgfaltspflichte bei Telemedien mit journalistisch-redaktionellen Angeboten Grundlagen des Urheberschutzes, Schutz des Urhebers, Verwertungsrechte, Übertragung von Urheberrechten, Tauschbörsen, Privatkopie Internetrecht, Domain-Namensrecht, Vertragsschluss im Internet, Verbraucherschutzrecht, Grundlagen von Datenschutzrechten Rechtsdurchsetzung, Verhandlungsführung, Konfliktmanagement: Havard-Konzept in Verhandlungen, Konfliktorientierung von Streitparteien, Kommunikation in Streitsituationen
Learning Objectives/ Learning Outcomes	Im Modul werden allgemein maßgebliche Rechtsfragen erörtert und hinterfragt, die für die Berufsfelder relevant sind. Die Teilnehmer werden in die Lage versetzt, ihr professionelles Handeln unter Berücksichtigung juristischer Kategorien zu vollziehen. Sie entwickeln ein grundlegendes Verständnis für diesen Bereich domänenspezifischen Handelns und werden für juristisch relevante Bereiche ihres Berufsfelds sensibilisiert. Sie erwerben anhand von Fallbeispielen Grundkenntnisse in den Bereichen Bürgerliches Recht, Arbeitsrecht sowie Medien- und Internetrecht. In der Übung werden die in der Vorlesung erworbenen Kenntnisse anhand eines konkreten Falles in Eigenarbeit und Besprechung vertieft.
(Study-Specific) Prerequisites	-
(recommended) Requirements	-
References	-

Non-Technical Elective Module
Civil Law (7022978)

Language	German
Examination Terms	90-minütige Klausur Die Modulnote ist die Note der Klausur.
Miscellaneous	-
Module coordinator	• Modulangebotsorganisation: LeMa-Team Philosophische Fakultät, modulangebotsorganisation@fb7.rwth-aachen.de • Modulverantwortliche: Univ.-Prof. Dr. phil. Eva-Maria Jakobs
ECTS Credits	4
Contact time (WSH)	4
Examination duration (min)	90
Total hours (h)	120,0
Contact hours (h)	60,0
Self-study hours (h)	60,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Written Exam Civil Law (702297801)	4th semester	no semester recommended	4	-

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Vorlesung „Bürgerliches Recht“	4th semester	no semester recommended	-	2
Übung „Bürgerliches Recht“	4th semester	no semester recommended	-	2

Module titel	Entrepreneurship 101 - Thinking like an entrepreneur and becoming one (Compulsory elective subject)
Identifier	8023959
Version	v1
Duration (Semester)	more semesters
Cycle (Semester)	winter/summer semester
Valid from	Summer semester 2021
Valid until	-
Module level	Master
Content	Participants first gain an insight into the field of entrepreneurship. They can then individually choose which focal topics in the field of entrepreneurship they would like to pursue, depending on their center of interest. Participants are offered a range of micromodules out of which they can design their individual learning path. This enables participants to customize the lecture based on their particular interest. Subjects to choose from, among others, include start-up financing, venture capital, entrepreneurial marketing as well as success factors of founding teams. The lecture takes place exclusively online via edX. The modules are self-paced, allowing participants to complete the modules at their individual learning pace. Due to the individually designable lecture, this course is suitable for participants with and without previous knowledge in this field. To gain an overall understanding of entrepreneurship, it is recommended to first select the micromodules "Thinking & Acting like an Entrepreneur“.
Learning Objectives/ Learning Outcomes	The aim of this course is to give the participant a basic insight into the topic of entrepreneurship on one hand, and to deepen their understanding in areas of particular interest on the other hand. This way, the participant gets to know different areas of entrepreneurship. Through exercises and quizzes, the new knowledge is directly applied and practiced.
(Study-Specific) Prerequisites	-
(recommended) Requirements	None.
References	-
Language	English
Examination Terms	Klausur (100%)
Miscellaneous	-
Module coordinator	Univ.-Prof. Dr. Malte Brettel
ECTS Credits	10
Contact time (WSH)	4
Examination duration (min)	-

– Non-Technical Elective Module
+ Entrepreneurship 101 - Thinking like an entrepreneur and ...

Total hours (h)	300,0
Contact hours (h)	60,0
Self-study hours (h)	240,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Entrepreneurship 101 - Thinking & Acting Like an Entrepreneur 1 (802395901)	5th semester	no semester recommended	1	-
Entrepreneurship 101 - Thinking & Acting Like an Entrepreneur 2 (802395902)	5th semester	no semester recommended	1	-
Entrepreneurship 101 - Thinking & Acting Like an Entrepreneur 3 (802395903)	5th semester	no semester recommended	1	-
Entrepreneurship 101 - Thinking & Acting Like an Entrepreneur 4 (802395904)	5th semester	no semester recommended	1	-
Entrepreneurship 101 - Start-up CFO 1 (802395905)	5th semester	no semester recommended	1	-
Entrepreneurship 101 - Start-up CFO 2 (802395906)	5th semester	no semester recommended	1	-
Entrepreneurship 101 - Venture Capital 1 (802395907)	5th semester	no semester recommended	1	-
Entrepreneurship 101 - Venture Capital 2 (802395908)	5th semester	no semester recommended	1	-
Entrepreneurship 101 - Getting to Market 1 (802395909)	5th semester	no semester recommended	1	-
Entrepreneurship 101 - Getting to Market 2 (802395910)	5th semester	no semester recommended	1	-

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Entrepreneurship 101 - Thinking & Acting Like an Entrepreneur 1	5th semester	no semester recommended	-	2
Entrepreneurship 101 - Thinking & Acting Like an Entrepreneur 2	5th semester	no semester recommended	-	2
Entrepreneurship 101 - Thinking & Acting Like an Entrepreneur 3	5th semester	no semester recommended	-	2

Entrepreneurship 101 - Thinking & Acting Like an Entrepreneur 4	5th semester	no semester recommended	-	2
Entrepreneurship 101 - Start-up CFO 1	5th semester	no semester recommended	-	2
Entrepreneurship 101 - Start-up CFO 2	5th semester	no semester recommended	-	2
Entrepreneurship 101 - Venture Capital 1	5th semester	no semester recommended	-	2
Entrepreneurship 101 - Venture Capital 2	5th semester	no semester recommended	-	2
Entrepreneurship 101 - Getting to Market 1	5th semester	no semester recommended	-	2
Entrepreneurship 101 - Getting to Market 2	5th semester	no semester recommended	-	2

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– Non-Technical Elective Module
+ Ethics, technology, and data (7017528)

Module titel	Ethics, technology, and data (Compulsory elective subject)
Identifier	7017528
Version	-
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Master
Content	The course will teach the basics of ethical theories and concepts. Based on an introduction to central theories and concepts, the course will focus on the application to topics of technology development, design, and of dealing with large amounts of data. The lecture will discuss classic, current, and future cases. The following topics will be introduced: - What does responsibility mean - professional, active, passive? - Normative theories – an overview - Values – identification and description - Normative reasoning - theory and exercises - Design, risk and responsibility The second part of the course will cover selected cases of technology and data ethics.
Learning Objectives/ Learning Outcomes	Skills: Regarding known and new cases of technology and data ethics: - Recognition, description and reflection of responsibilities - Identification, description and reflection of moral problems - Identification, reflection and discussion of values in the context of technology development and data handling - Active participation in discussions on in-depth topics of technology and data ethics Competences: Prepare, present and discuss concepts and argumentation strategies of a scientific topic of technology and data ethics.
(Study-Specific) Prerequisites	-
(recommended) Requirements	-
References	-
Language	English
Examination Terms	Will be announced at beginning of semester. It will be a combination of written and oral assessment, considering formative and summative aspects.
Miscellaneous	-
Module coordinator	• Univ.-Prof. Nagel, Saskia Kathi • Dr. phil. Plum-Rieger, Angelika, lema@fb7.rwth-aachen.de
ECTS Credits	4
Contact time (WSH)	2

– Non-Technical Elective Module
+ Ethics, technology, and data (7017528)

Examination duration (min)	60-150
Total hours (h)	120,0
Contact hours (h)	30,0
Self-study hours (h)	90,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Oral or written Exam (701752801)	4th semester	no semester recommended	4	0

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Ethics of Data Science	4th semester	no semester recommended	-	2

Module titel	Principles of Management (Compulsory elective subject)
Identifier	8024098
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2021
Valid until	-
Module level	Bachelor
Content	Dieser Kurs gibt einen Überblick über grundlegende Modelle, Theorien und Prinzipien der Betriebswirtschaftslehre. Der Kurs beginnt mit der Frage, warum es Unternehmen gibt und was der Kern unternehmerischer Wertschöpfung ist. Anschließend wird analysiert, welche Alternativen und Theorien es zur Organisation von Unternehmen gibt. Ein Schwerpunkt auf die neue Institutionenökonomie erlaubt dabei einen Einblick in einen der Ansätze, der das moderne Management entscheidend geprägt hat. In den letzten beiden Teilen werden Prinzipien der operativen Planung sowie Sustainability behandelt. Anhand ausgewählter Konzepte lernen die Teilnehmenden die wichtigsten Ansätze einer nachhaltigen Unternehmensführung kennen. ; Dieser Kurs besteht aus insgesamt sechs Modulen und einem Exkurs: Modul 1: Grundzüge und Funktionen der Unternehmung Modul 2: Organisationstheorien: Der Weg zum Taylorismus und dessen Überwindung Modul 3: Gestaltung der Organisationsstruktur Modul 4: Neue Institutionenökonomik Modul 5: Operative Planung Modul 6: Sustainability ; Exkurs: Economies of Scale and Scope
Learning Objectives/ Learning Outcomes	- Die Teilnehmenden kennen grundlegende Denkweisen der Betriebswirtschaftslehre. - Die Teilnehmenden können wesentliche Fachbegriffe ebenso wie grundlegende Konzepte auf aktuelle Fragestellungen übertragen. - Die Teilnehmenden können einen Bezug zwischen den theoretisch vermittelten Kursinhalten und der unternehmerischen Praxis herzustellen. - Die Teilnehmenden verfügen über eine kritisch-reflektierte Herangehensweise an wirtschaftliche Fragestellungen. - Die Teilnehmenden verfügen über einen Rahmen für weitere vertiefende Vorlesungen im Bereich BWL.
(Study-Specific) Prerequisites	-
(recommended) Requirements	None
References	-
Language	German

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– Non-Technical Elective Module
+ Principles of Management (8024098)

Examination Terms	Klausur (100%, benotet) und Modulbaustein (im Falle des Bestehens der Klausur, kann durch erfolgreiche Teilnahme an semesterbegleitenden e-learning Hausaufgaben eine Verbesserung der Klausurnote um 0.3 bzw. 0.4 erreicht werden, wenn über 70% der möglichen Punkte erreicht wurden. Es kann eine Verbesserung um 0.6 bzw. 0.7 erreicht werden, wenn über 95% der möglichen Punkte erreicht wurden). Die Klausur und Wiederholungsklausur werden zu Beginn bzw. Ende des auf das jeweilige Wintersemester folgenden Prüfungszeitraums angeboten.
Miscellaneous	-
Module coordinator	Univ.-Prof. Dr.rer.pol. Frank Thomas Piller
ECTS Credits	4
Contact time (WSH)	3
Examination duration (min)	60
Total hours (h)	120,0
Contact hours (h)	45,0
Self-study hours (h)	75,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Principles of Management (Exam (802409801)	5th semester	no semester recommended	4	-

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Principles of Management (Lecture)	5th semester	no semester recommended	-	2
Principles of Management (Tutorial)	5th semester	no semester recommended	-	1

Non-Technical Elective Module
Non-Technical Elective Module Mentoring (1220643)

Module titel	Non-Technical Elective Module Mentoring (Compulsory elective subject)
Identifier	1220643
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Summer semester 2019
Valid until	-
Module level	-
Content	Content: The non-technical elective "Mentoring" prepares participants for their role and tasks as student mentors. It combines theory with practical application. In addition to in-depth knowledge of the contents described in the curriculum of the Computer Science Mentoring Program, the following topics are taught: Role finding and role identification, group processes and group dynamics, didactic and methodological basics, basics of Constructive Alignment, interview techniques, presentation techniques, background knowledge and strategies for time and self-management as well as self-directed learning. Translated In the weekly mentoring briefings, participants prepare the content and methodology of the first-semester group meetings based on clear guidelines and the work materials and learning materials provided in the RWTHmoodle learning room. In their first-semester groups, participants implement the knowledge and skills they have learned. Continuous reflection phases open up scope for professional and personal development. By dovetailing theory and practice, participants acquire and improve important key competencies such as social competence, leadership skills, or organizational competence, which are useful for further professional and private life beyond the mentoring activity. Learning objective: Based on the knowledge and skills acquired in the module, students will be able to: • organize and expertly guide themselves and their first semester group through the first semester; • respond appropriately to typical mentoring situations; • communicate the content of the mentoring program; • make the mentoring appointments interesting and conducive to learning.
Learning Objectives/ Learning Outcomes	-
(Study-Specific) Prerequisites	None.
(recommended) Requirements	None.
References	-
Language	-
Examination Terms	The examination type variies between modules.
Miscellaneous	-
Module coordinator	-

– Non-Technical Elective Module
+ Non-Technical Elective Module Mentoring (1220643)

ECTS Credits	4
Contact time (WSH)	3
Examination duration (min)	-
Total hours (h)	120,0
Contact hours (h)	45,0
Self-study hours (h)	75,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Mentoring (122064301)	5th semester	no semester recommended	4	3

Non-Technical Elective Module
Project "Leonardo" - Protocol with Analysis (7028183)

Module titel	Project "Leonardo" - Protocol with Analysis (Compulsory elective subject)
Identifier	7028183
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2022
Valid until	-
Module level	Bachelor/Master
Content	Die einzelnen Lehrveranstaltungen adressieren in vielfältiger Weise aktuelle und globale Herausforderungen, die interdisziplinär diskutiert und reflektiert werden. Dozierende aus verschiedenen Fachrichtungen übernehmen die Durchführung der einzelnen Veranstaltungen und beleuchten die jeweiligen Themen aus unterschiedlichen Disziplinen.
Learning Objectives/ Learning Outcomes	Die Studierenden sollen durch die gemeinsame, interdisziplinäre Arbeit nicht nur die unterschiedlichen Denkweisen und Ansätze verschiedener Disziplinen kennenlernen, sondern auch Kommilitoninnen und Kommilitonen anderer Fachbereiche und Studienrichtungen der RWTH Aachen und auf diese Weise ganz konkret die "universitas" in ihrer ursprünglichen Bedeutung als wissenschaftliche Gemeinschaft erfahren.
(Study-Specific) Prerequisites	-
(recommended) Requirements	-
References	-
Language	German/English
Examination Terms	Protokoll mit Analyse (unbenotet)
Miscellaneous	-
Module coordinator	• Modulangebotsorganisation: LeMa-Team Philosophische Fakultät, modulangebotsorganisation@fb7.rwth-aachen.de • Modulverantwortung: Univ.-Prof. Dr. phil. Stefan Böschen
ECTS Credits	2
Contact time (WSH)	-
Examination duration (min)	-
Total hours (h)	60,0
Contact hours (h)	-
Self-study hours (h)	-

+ Project "Leonardo" - Protocol with Analysis (7028183)

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Project "Leonardo": Protocol with Analysis (702818301)	5th semester	no semester recommended	2	-

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Project "Leonardo": Protocol with Analysis	5th semester	no semester recommended	-	-

Non-Technical Elective Module
Project "Leonardo" - Study Paper (7028184)

Module titel	Project "Leonardo" - Study Paper (Compulsory elective subject)
Identifier	7028184
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2022
Valid until	-
Module level	Bachelor/Master
Content	Die einzelnen Lehrveranstaltungen adressieren in vielfältiger Weise aktuelle und globale Herausforderungen, die interdisziplinär diskutiert und reflektiert werden. Dozierende aus verschiedenen Fachrichtungen übernehmen die Durchführung der einzelnen Veranstaltungen und beleuchten die jeweiligen Themen aus unterschiedlichen Disziplinen.
Learning Objectives/ Learning Outcomes	Die Studierenden sollen durch die gemeinsame, interdisziplinäre Arbeit nicht nur die unterschiedlichen Denkweisen und Ansätze verschiedener Disziplinen kennenlernen, sondern auch Kommilitoninnen und Kommilitonen anderer Fachbereiche und Studienrichtungen der RWTH Aachen und auf diese Weise ganz konkret die "universitas" in ihrer ursprünglichen Bedeutung als wissenschaftliche Gemeinschaft erfahren.
(Study-Specific) Prerequisites	-
(recommended) Requirements	-
References	-
Language	German/English
Examination Terms	Erstellung einer Studienarbeit (15-20 Seiten), benotet
Miscellaneous	-
Module coordinator	• Modulangebotsorganisation: LeMa-Team Philosophische Fakultät, modulangebotsorganisation@fb7.rwth-aachen.de • Modulverantwortung: Univ.-Prof. Dr. phil. Stefan Böschen
ECTS Credits	4
Contact time (WSH)	-
Examination duration (min)	-
Total hours (h)	120,0
Contact hours (h)	-
Self-study hours (h)	-

Non-Technical Elective Module
Project "Leonardo" - Study Paper (7028184)

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Project "Leonardo": Study Paper (702818401)	5th semester	no semester recommended	4	-

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Project "Leonardo": Study Paper	5th semester	no semester recommended	-	-

Module titel	Project "Leonardo" - Protocol with Analysis – second Examination (Compulsory elective subject)
Identifier	7029186
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Summer semester 2023
Valid until	-
Module level	Bachelor/Master
Content	Die einzelnen Lehrveranstaltungen adressieren in vielfältiger Weise aktuelle und globale Herausforderungen, die interdisziplinär diskutiert und reflektiert werden. Dozierende aus verschiedenen Fachrichtungen übernehmen die Durchführung der einzelnen Veranstaltungen und beleuchten die jeweiligen Themen aus unterschiedlichen Disziplinen.
Learning Objectives/ Learning Outcomes	Die Studierenden sollen durch die gemeinsame, interdisziplinäre Arbeit nicht nur die unterschiedlichen Denkweisen und Ansätze verschiedener Disziplinen kennenlernen, sondern auch Kommilitoninnen und Kommilitonen anderer Fachbereiche und Stu-dien-richtungen der RWTH Aachen und auf diese Weise ganz konkret die "univer-sitas" in ihrer ursprünglichen Bedeutung als wissenschaftliche Gemeinschaft erfah-ren.
(Study-Specific) Prerequisites	-
(recommended) Requirements	-
References	-
Language	German/English
Examination Terms	Protokoll mit Analyse (unbenotet)
Miscellaneous	-
Module coordinator	• Modulangebotsorganisation: LeMa-Team Philosophische Fakultät, modulangebotsorganisation@fb7.rwth-aachen.de • Modulverantwortung: Univ.-Prof. Dr. phil. Stefan Böschen
ECTS Credits	2
Contact time (WSH)	0
Examination duration (min)	-
Total hours (h)	60,0
Contact hours (h)	,0
Self-study hours (h)	60,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Project "Leonardo": Protocol with Analysis – second Examination (702918601)	5th semester	no semester recommended	2	0

Non-Technical Elective Module
Language Course (1225243)

Module titel	Language Course (Compulsory elective subject)
Identifier	1225243
Version	V1
Duration (Semester)	-
Cycle (Semester)	-
Valid from	Winter semester 2018
Valid until	-
Module level	-
Content	-
Learning Objectives/ Learning Outcomes	-
(Study-Specific) Prerequisites	-
(recommended) Requirements	-
References	-
Language	-
Examination Terms	-
Miscellaneous	-
Module coordinator	-
ECTS Credits	-
Contact time (WSH)	-
Examination duration (min)	-
Total hours (h)	-
Contact hours (h)	-
Self-study hours (h)	-

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Language Course (122524301)	5th semester	no semester recommended	-	-

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Non-Technical Elective Module
Language Course (1225244)

Module titel	Language Course (Compulsory elective subject)
Identifier	1225244
Version	V1
Duration (Semester)	-
Cycle (Semester)	-
Valid from	Winter semester 2018
Valid until	-
Module level	-
Content	-
Learning Objectives/ Learning Outcomes	-
(Study-Specific) Prerequisites	-
(recommended) Requirements	-
References	-
Language	-
Examination Terms	-
Miscellaneous	-
Module coordinator	-
ECTS Credits	-
Contact time (WSH)	-
Examination duration (min)	-
Total hours (h)	-
Contact hours (h)	-
Self-study hours (h)	-

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Language Course (122524401)	5th semester	no semester recommended	-	-

– Non-Technical Elective Module
+ Law in Computer Science (1227459)

Module titel	Law in Computer Science (Compulsory elective subject)
Identifier	1227459
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Summer semester 2023
Valid until	-
Module level	Bachelor
Content	The module offers interested students a scientifically based legal course. Computer science students need non-technical skills in addition to their technical expertise. Legal knowledge is not only advantageous for later professional activities, but also meets interest of computer science students because jurisprudence is also largely based on systematic and logical considerations. Therefore, the working lecture emphasizes the methodical comprehension of the legal system as a whole and of individual legal regulations. The first part of the course lays the foundation of legal reasoning, in which the structure of the legal order is shown and students grasp that a subsumption activity necessary for case solution involves the decomposition of legal provisions into facts and legal consequences. In the second part of the lecture, experts from the field of IT law and data protection law will have their say. Finally, the legal foundations of business start-ups will be addressed and possibilities of enforcing the law and settling conflicts will be shown. The following topics are covered in the module: • Introduction to the legal system, areas of law, facts and legal consequences, interpretation of legal provisions • Conclusion of contract, legal obligations and liabilities after conclusion of contract, defects of will and rescission • Consumer protection, especially for distance contracts • Sales contract and contract for work and services, seller's and contractor's liability for defects • Product liability and tort, liability in case of accidents • Rights of defendants in criminal proceedings • Founding start-ups and spin-offs, basics of corporate law, liability issues and contracts with investors. ; Securing credit • Copyright law, especially for software products • Data protection law, basic data protection regulation • IT software law, purchase/sale of digital products, such as IT products or licenses • Conflict resolution and enforcement of rights
Learning Objectives/ Learning Outcomes	Knowledge: The students possess basic knowledge in the areas of civil contract law, product liability law, labor law and criminal law. Furthermore, students acquire specialized knowledge in technical areas. This includes above all copyright law, data protection law and IT software law. Skills: Students are able to carry out their professional actions taking into account legal categories. They develop a basic understanding of domain-specific action and are sensitized to legal areas of their upcoming professional field. To this end, they become familiar with various methods of enforcing the law and resolving conflicts. Acquired legal knowledge will be deepened in all parts of the lecture by means of concrete cases in individual work and discussion. Competences: After completion of the module, students are able to protect themselves from liability risks and to develop and distribute products in a legally secure manner through basic legal knowledge.

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Non-Technical Elective Module
Law in Computer Science (1227459)

(Study-Specific) Prerequisites	-
(recommended) Requirements	-
References	-
Language	German
Examination Terms	Written exam (100%).
Miscellaneous	-
Module coordinator	Honorarprofessor Dr. jur. Uwe Meiendresch
ECTS Credits	4
Contact time (WSH)	4
Examination duration (min)	90-120 min
Total hours (h)	120,0
Contact hours (h)	60,0
Self-study hours (h)	60,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Law in Computer Science (122745902)	4th semester	no semester recommended	0	2
Exam Law in Computer Science (122745901)	4th semester	no semester recommended	4	-

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Law in Computer Science	4th semester	no semester recommended	-	2

Non-Technical Elective Module
Social Psychology (7021318)

Module titel	Social Psychology (Compulsory elective subject)
Identifier	7021318
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Summer semester 2024
Valid until	-
Module level	Bachelor
Content	This lecture will provide students with an introduction to the field of social psychology. Social psychology is a subfield of the science of psychology that focuses on the per-ceptions, thoughts, feelings, and behaviors of individuals and groups within a social context. This lecture will give you a broad overview of the major theories and concepts and corresponding findings within social psychology. Specific Contents: • History and methods in social psychology • Person perception • Stereotypes • Attitudes and persuasion • Self-concept • Conflict and aggression • Social influence and conformity • Prosocial behavior • Interpersonal attraction • Behavior in groups
Learning Objectives/ Learning Outcomes	Goal of this module is to enable students to understand observations and events in their daily interactions as social phenomena and explain these phenomena by using theories and concepts from social psychology. Students will be able to establish relationships to questions in other disciplines such as business science, pedagogy, communication science, and sociology. After the course students will 1) have gained knowledge of the major theories and current findings in social psychology, 2) have gained knowledge on the scientific method underlying social psychology research, 3) be able to recognize and appreciate how theory and experimental findings apply to everyday situations.
(Study-Specific) Prerequisites	-
(recommended) Requirements	-
References	English: Aronson, E., Wilson, T. D., & Akert, R. M. (2005). Social psychology (pp. 324-25). Upper Saddle River, NJ: Prentice Hall. German: Aronson, E., Akert, R. M., & Wilson, T. D. (2010). Sozialpsychologie. Pearson Deutschland GmbH.
Language	English
Examination Terms	The grading results from 100% of the final exam of this module. The exam can be a written or an oral exam. The final form of the examination is announced at the beginning of the lecture.
Miscellaneous	-
Module coordinator	• Modulangebotsorganisation: LeMa-Team Philosophische Fakultät, modulangebotsorganisation@fb7.rwth-aachen.de

Non-Technical Elective Module
Social Psychology (7021318)

	• Modulverantwortliche: Univ.-Prof. Dr. rer. nat. Astrid Rosenthal-von der Pütten
ECTS Credits	4
Contact time (WSH)	2
Examination duration (min)	60
Total hours (h)	120,0
Contact hours (h)	30,0
Self-study hours (h)	90,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Social Psychology (702131801)	5th semester	no semester recommended	4	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Social Psychology	5th semester	no semester recommended	-	2

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Seminar from other Faculties/Departments
Seminar: Mathematical Concepts of Machine Learning (4028624)

Module titel	Seminar: Mathematical Concepts of Machine Learning (Compulsory subject)
Identifier	4028624
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Summer semester 2023
Valid until	-
Module level	Master
Content	The use of machine learning and artificial intelligence has a huge potential for building future engineering systems such as autonomous robots, vehicles, or smart infra-structure systems. This is an interdisciplinary seminar offered in mechanical engineering and computer science due to the interdisciplinary nature of the topic. In addition to the challenges of designing ML and AI systems, it is critical to analyze the mathematical properties of these algorithms. This seminar will focus on some of the underlying mathematics of modern methods. The number of places for this seminar is limited.
Learning Objectives/ Learning Outcomes	<u>Knowledge and understanding:</u> You will leam about topics of current research in machine learning and focus on the underlying mathematical concepts. Many modern machine learning methods are readily implemented and can be used rather straightforwardly on a given data set. However, often this yields poor results. Thus, it is important to understand how the algorithms work and what mathematical properties of the data are critical to ensure good performance. A prominent example is correlated data, which can have dramatic consequences for certain methods and be manageable for others. The amount and quality of data is also an important aspect that heavily influences the success of the leaming outcome. <u>Skills and competencies:</u> You will prepare an assigned topic, familiarize with the mathematical details, and give a presentation to your peers. There will be theorems and proofs. You need to under-stand and reproduce the mathematical arguments, reasoning and rigor.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Recommended prerequisites: Prior knowledge in probability theory and machine learning is recommended.
References	-
Language	English
Examination Terms	The attendance of the course is mandatory. Presentation (40%) and written report (60%).
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. Sebastian Trimpe
ECTS Credits	4

+ Seminar: Mathematical Concepts of Machine Learning (4028624)

Contact time (WSH)	3
Examination duration (min)	-
Total hours (h)	120,0
Contact hours (h)	45,0
Self-study hours (h)	75,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Seminar: Mathematical Concepts of Ma-chine Learning (402862401)	5th semester	no semester recommended	4	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Seminar: Mathematical Concepts of Machine Learning	5th semester	no semester recommended	-	3

Module titel	Computer Vision (Compulsory elective subject)
Identifier	1215724
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Summer semester 2018
Valid until	-
Module level	Bachelor/Master
Content	Image Processing Basics, Image Segmentation, Object Recognition, Object Categorization, 3D Reconstruction, Application of current Machine Learning methods to the above-mentioned problems.
Learning Objectives/ Learning Outcomes	Knowledge: On successful completion of this module, lecture participants should be able to recall and explain the theoretical foundations underlying Computer Vision techniques in the areas mentioned under “Content”. | Skills: Lecture participants can derive and explain methods and techniques that enable a machine to analyze the content of images and videos and to derive an understanding of the image content. They know the current research trends and developments. This enables them to select the basic Computer Vision techniques necessary for those capabilities. | Competences: Lecture participants are able to apply the covered methods to real problems on their own. They are able to implement the covered algorithms themselves in a language of their choice.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Basic knowledge in linear algebra, probability theory and statistics is recommended.
References	R. Szeliski, Computer Vision - Algorithms and Applications, Springer, 2010 | K. Grauman, B. Leibe, Visual Object Recognition, Morgan & Kaufman publishers, 2011 | I. Goodfellow, Y. Bengio, A. Courville, Deep Learning, 2016 | R. Hartley, A. Zisserman. Multiple View Geometry in Computer Vision, 2nd Edition, Cambridge University Press, 2004.
Language	English
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. sc. techn. Bastian Leibe
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	15-45 (mündlich/oral) | 90-120 (schriftlich/written)
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Computer Vision (121572402)	5th semester	no semester recommended	0	1
Exam Computer Vision (121572401)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Computer Vision	5th semester	no semester recommended	-	3

Module titel	Designing Interactive Systems I (Compulsory elective subject)
Identifier	1215698
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	This class introduces students to human-computer interaction (HCI) and user interface design. It covers the following topics: Fundamental characteristics of human cognition, such as reaction time, rules of perception, and memory performance, Models of interaction between people and their environment, such as affordances, mappings, constraints, slips and mistakes, Milestones in the history of human-computer interaction, Principles of iterative design, User interface prototyping techniques, Golden rules of user interface design, User interface design notations, User studies and evaluation methods.
Learning Objectives/ Learning Outcomes	Knowledge: After this class, students will know how user interfaces have developed over the past decades, and what constants of human performance need to be considered when designing them. | Skills: They will be able to apply iterative design, prototyping, and evaluation methods to design usable, appropriate user interfaces in a user-centered fashion. All assignments are group assignments to foster collaboration skills, and project-based to strengthen project planning, conflict management and presentation skills. | Competences: Students learn to think in designers' terms. This is a crucial competence for computer scientists working on user interfaces, a job that requires collaboration in interdisciplinary teams.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	None.
References	D. Norman: The Design Of Everyday Things, Basic Books 2002 (verpflichtend für die ersten Wochen des Kurses), plus Auszüge aus A. Dix et al.: Human-Computer Interaction, Prentice-Hall 2004. Shneiderman et al.: Designing The User Interf. Add.-W. 2004, J. Raskin: The Humane Interface, Addison-Wesley, 2000
Language	English
Examination Terms	The module examination consists of the following partial qualifications: ;;Project work with presentation (40 %); Written exam or oral examination (60 ;;%). Students must pass written homework to be admitted to the examination. ;
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. rer. nat. Jan Oliver Borchers
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	-

– Electives
– Elective Applied Computer Science
+ Designing Interactive Systems I (1215698)

Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Designing Interactive Systems I (121569802)	5th semester	no semester recommended	0	2
Exam Designing Interactive Systems I (121569801)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Designing Interactive Systems I	5th semester	no semester recommended	-	3

Module titel	Computer Graphics (Compulsory elective subject)
Identifier	1212310
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2007
Valid until	-
Module level	Bachelor/Master
Content	Foundations of geometry representations (polygonal meshes, volumetric representations, freeform curves and surfaces), local illumination (3D transformations, clipping, rasterization, lighting, shading), global illumination (visibility, shadow computation, ray tracing, radiosity), foundations of image processing (transformations, color coding, image compression), volume rendering.
Learning Objectives/ Learning Outcomes	Knowledge of the most important data structures for the representation of three-dimensional objects and scene descriptions. Skills: Learning the elementary operations and methods for transforming a 3D model into a realistic two-dimensional image (rendering pipeline). Competences: Overview of the central problems and their efficient solutions in the field of computer graphics.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Knowledge about Algorithms and Data Structures and Linear Algebra.
References	Tomas Akenine-Möller et al.: Real-Time Rendering (3rd Edition). Taylor & Francis, 2008 | Alan Watt: 3D Computer Graphics (3rd Edition). Addison-Wesley, 1993
Language	German/English
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. rer. nat. Leif Kobbelt
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	15-45 (mündlich/oral) | 90-120 (schriftlich/written)
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercises Introduction to Computer Graphics (121231002)	5th semester	no semester recommended	0	3
Exam Introduction to Computer Graphics (121231001)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Introduction to Computer Graphics	5th semester	no semester recommended	-	2

Module titel	High-Performance Computing (Compulsory elective subject)
Identifier	1215720
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	• Characteristics of micro architectures • Parallel computer architectures • Network topologies • Blocking algorithms to exploit data locality in deep memory hierarchies • Design principles of parallel algorithms • Modelling parallelism (speedup, efficiency, Amdahl) and performance • Introduction to parallel programming • Further selected topics
Learning Objectives/ Learning Outcomes	Acquisition of knowledge and skills as follows: • Comprehension of the main parallel computer architectures • Knowledge on basic design methodologies for data-local serial and parallel algorithms • Skills to apply basic methods for the analysis of runtime behavior of parallel algorithms • Comprehension of elementary operations in parallel programming
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Skills in the main concepts of imperative and object-oriented programming languages, as well as elementary programming techniques in these languages (Lecture on Programming)
References	PDF-Dateien der Folien und Übungen (zum Download), sowie: • G. Hager and G. Wellein: Introduction to High Performance Computing for Scientists and Engineers. CRC Computation Science Series, 2010. ISBN: 978-1-4398-1192-4. • J. Hennessy and D. Patterson: Computer Architecture. A Quantitative Approach. Morgan Kaufmann Publishers, Elsevier, 2011. ISBN: 978-0123838728.
Language	English
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Modulangebotsverantwortlicher InformatikModellierungsteamverantwortlicher: Dr. rer. nat. Katja PetzoldtModulverantworlicher: Universitätsprofessor Dr. rer. nat. Matthias Müller
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	0

– Electives
– Elective Applied Computer Science
+ High-Performance Computing (1215720)

Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam High-Performance Computing (121572001)	6th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture + Exercise High-Performance Computing	6th semester	no semester recommended	-	3

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Module titel	iOS Application Development (Compulsory elective subject)
Identifier	1215681
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	In this class you learn how to develop mobile application on iOS devices. It covers the following topics: Introduction of the programming language Swift, Xcode, Storyboards, Model-View-Controller for iOS, App Frameworks (e.g. UiKit, Foundation), Debugging with Instruments, Basis iOS Development Frameworks (e.g. MapKit, CoreData, Core Location), iOS Graphics and Games Frameworks (e.g. Sprite Kit, Scene Kit), Publish Apps in the AppStore.
Learning Objectives/ Learning Outcomes	Knowledge: On successful completion of this module, students should be able to define the structure of a modern mobile application SDK, recall mobile application design guidelines and explain key software architecture concepts heavily used in the iOS SDK. Furthermore, the will be able to state the differences between mobile and desktop computing and provide an overview of the frameworks provided by the iOS SDK | Skills: They should be able to effectively implement their own iOS Apps, use the iOS development environment in depth and apply an iterative software development process. | Competences: Based on the knowledge and skills acquired students will reach the competence of communicating/working in a team, of applying the design guidelines to a specific application scenario and of setting up a development plan for a defined application to convincingly present their results.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Knowledge on basics in object-oriented software development.
References	Neuste Version “Programming Fundamentals with Swift” von Matt Neuburg, Verleger: O’Reilly Media
Language	English
Examination Terms	The module examination consists of the following partial qualifications: ;Presentation with written paper (20 %); project work with presentation (50 %); written exam (30 %). Attendance is mandatory for the presentations and the project work.
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. rer. nat. Jan Oliver Borchers &; Dr. rer. nat. Simon Völker
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	-
Total hours (h)	180,0

Contact hours (h)	75,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam iOS Application Development (121568101)	5th semester	no semester recommended	6	0
Exercise iOS Application Development (121568102)	5th semester	no semester recommended	0	2

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture iOS Application Development	5th semester	no semester recommended	-	3

Module titel	Concepts and Models for Parallel and Data-centric Programming (Compulsory elective subject)
Identifier	1216838
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	• Architecture of parallel computers (cluster) in use in High Performance Computing and for the analysis of large data volumes • Parallel Programming Models: instruction-level, accelerators, shared memory, distributed memory, MapReduce concept • Parallel I/O • Synchronization concepts of parallel programming models • Realization of relevant (abstract) datatypes with parallel programming models • Selected parallel algorithms • Modelling of parallelism (speedup, efficiency, scalability limits) and performance • Selected other topics
Learning Objectives/ Learning Outcomes	After successful participation in the course, students have acquired knowledge and skills in the subject areas described under Contents. Thus, they are particularly familiar with the characteristics of parallel computers, I/O and data analysis systems and their architectures that are essential for parallel programming, as well as with the programming models for parallel programming of these systems on different levels. This includes in particular data input and output. For all of these levels, the relevant concepts for the expression of parallelism and synchronization as well as for the implementation of frequently used (abstract) data structures are discussed. In addition, methods for designing and evaluating the performance of the resulting programs are taught. This enables the students to describe parallel systems in use in High Performance Computing (HPC) and for processing large amounts of data (Big Data) and to classify them with respect to the development of technologies. They can explain, differentiate and evaluate optimization and parallelization concepts. They know a selection of parallel algorithms for the named systems from different application areas and they can design and evaluate new parallel algorithms. They are also familiar with the most important aspects of implementing the various programming models. In addition to the algorithms discussed, they know complexity properties and scalability limits. Students will become proficient in methods for determining the potential runtimes and performance limits of parallel algorithms and their application to known system architectures. These include implementations for clusters, for multi and many-core architectures, as well as for data analysis based on the MapReduce concept. They also have the ability to implement parallel programs and select fundamental optimizations in terms of performance, efficiency or energy consumption. They are thus familiar with relevant concepts, operations and algorithmic approaches of parallel programming and can use them.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Knowledge from 'Programming'. Knowledge from 'High Performance Computing' is helpful but not required.
References	PDF-Dateien der Folien und Übungen (zum Download) PDF-Dateien als einzelne Handreichungen zu ausgewählten Themen zur Bearbeitung vorab (zum Download)
Language	English

Examination Terms	Written Exam (100 %). Students must pass written homework to be admitted to the examination.
Miscellaneous	-
Module coordinator	Dr. rer. nat. Christian Terboven & Universitätsprofessor Dr. rer. nat. Matthias S. Müller
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	0
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Concepts and Models for Parallel and Data-centric Programming (121683802)	6th semester	no semester recommended	0	1
Exam Concepts and Models for Parallel and Data-centric Programming (121683801)	6th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Concepts and Models for Parallel and Data-centric Programming	6th semester	no semester recommended	-	3

Module titel	Performance Analysis and Correctness Checking of Parallel Applications (Compulsory elective subject)
Identifier	1215722
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	• Scalability of parallel applications • Performance-Monitoring (Profiling, Tracing, Event-Driven, Sample-Driven) • Instrumentation • Performance-analysis methods Classes of errors (Deadlocks, Race Conditions) • Classical debugging technology • Methods of error detection (static program analysis, run time detection, formal methods) • Errors using MPI • Deadlock detection Software design methods to avoid and detect errors (Assertions, Correctness-by-Construction)
Learning Objectives/ Learning Outcomes	• Methods for performance analysis of parallel application • Validation and error detection of parallel applications
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Knowledge in serial programming languages and elementary programming technics (lecture Programming) Knowledge of the fundamental concepts of parallel programming (lecture Introduction to High-Performance Computing) .
References	Raj Jain: The Art of Computer Systems Performance Analysis John Wiley &; Sons, Inc., 1991 (ISBN: 0-471-50336-3)
Language	German
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Modulangebotsverantwortlicher InformatikModellierungsteamverantwortlicher: Dr. rer. nat. Katja PetzoldtModulverantworlicher: Universitätsprofessor Dr. rer. nat. Matthias Müller
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	0
Total hours (h)	180,0

Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercises Introduction to Performance Analysis and Correctness Checking of Parallel Applications (121572202)	6th semester	no semester recommended	0	1
Exam Introduction to Performance Analysis and Correctness Checking of Parallel Applications (121572201)	6th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Introduction to Performance Analysis and Correctness Checking of Parallel Applications	6th semester	no semester recommended	-	3

Module titel	Physically-Based Animation (Compulsory elective subject)
Identifier	1215862
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	Basics of physically-based animation, particle systems, rigid bodies, simulation of deformable solids using discrete and continuous models, fluid simulation, collision detection and collision response.
Learning Objectives/ Learning Outcomes	Knowledge: understanding of state-of-the-art simulation methods for rigid bodies, deformable solids and fluids, experience in real-time simulation in computer graphics, collision detection algorithms. | Skills: implementation of the introduced techniques. | Competences: analysis of problems in the area of physically-based animation, choice of suitable methods to solve specific problems in this area, evaluation of simulation methods, extension of the introduced methods by own ideas.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Basic knowledge of numerics, algorithms and data structures and computer graphics.
References	Will be announced in the lecture.
Language	German
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. rer. nat. Jan Stephen Bender
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	15-45 (mündlich/oral) | 90-120 (schriftlich/written)
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Physically Based Animation (121586202)	5th semester	no semester recommended	0	1
Exam Physically-Based Animation (121586201)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Physically Based Animation	5th semester	no semester recommended	-	3

Module titel	Statistical Methods in Natural Language Processing (Compulsory elective subject)
Identifier	1215695
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Summer semester 2018
Valid until	-
Module level	Bachelor/Master
Content	Introduction/Motivation | Linguistic and Statistical Foundations | Text and Document Classification | Language Modelling | Part-of-Speech (POS) Tagging | Information Extraction by Tagging | Probabilistic Context Free Grammars and Parsing | Machine Translation
Learning Objectives/ Learning Outcomes	Knowledge: On successful completion of this module, students should be able to:describe the various applications of advanced state-of-the-art methods of Natural Language Processing. | describe the fundamental properties and methods of Natural Language Processing. | describe the advanced methods for training a Natural Language Processing: system. | describe the trade-off between system complexity and performance in an advanced Natural Language Processing system. Skills: They should be able to:to train the parameters of a Natural Language Processing system using advanced training methods. | apply and implement advanced methods of Natural Language Processing | measure and analyse the performance of a Natural Language Processing | system in complex real-life applications. Competences: Based on the knowledge and skills acquired they should:have an overview of advanced methods in Natural Language Processing. | be able to apply advanced methods of Natural Language Processing. | be in a position to analyze specific problems in a real-life application of Natural Language Processing systems.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Knowledge from „Einführung in die Stochastik“, „Datenstrukturen und Algorithmen“, „Formale Systeme, Automaten, Prozesse“.
References	C. D. Manning, H. Schütze: Foundations of Statistical Natural Language Processing. MIT Press, Cambridge, MA, 1999. | D. Jurafsky, J. H. Martin: Speech and Language Processing. Prentice Hall, Englewood Cliffs, NJ, 2000. | Folien/Lecture Notes: http://www-i6.informatik.rwth-aachen.de/web/Teaching/
Language	German/English
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr.-Ing. Hermann Ney
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	15-45 (mündlich/oral) | 90-120 (schriftlich/written)
Total hours (h)	180,0

Contact hours (h)	75,0
Self-study hours (h)	105,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercises Statistical Methods in Natural Language Processing (121569502)	6th semester	no semester recommended	0	2
Exam Statistical Methods in Natural Language Processing (121569501)	6th semester	no semester recommended	6	0

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Statistical Methods in Natural Language Processing	6th semester	no semester recommended	-	3

Module titel	Fundamentals of Automatic Speech Recognition (Compulsory elective subject)
Identifier	1230106
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	irregularly
Valid from	Winter semester 2024
Valid until	-
Module level	Bachelor
Content	• Introduction. • Speech signal processing. • Sequence alignment. • Isolated word recognition. • Statistical approach and modeling. • Sequence learning. • Connected Speech Recognition.
Learning Objectives/ Learning Outcomes	Knowledge: On successful completion of this module, students should be able to: • describe the components and formalisms of a statistical automatic speech recognition system; • state the optimization problems underlying training and recognition using statistical automatic speech recognition components and underlying models. Skills: They should be able to: • apply automatic speech recognition components; • ;solve the optimization problems underlying training and recognition using automatic speech recognition components and underlying models; • should have acquired soft skills like developing and testing ASR software components in a cooperative environment. Competences: Based on the knowledge and skills acquired they should: • have an overview of the fundamentals of automatic speech recognition; • be able to analyze the effect of the components of statistical automatic speech recognition systems; • be able to interpret the implementation of a speech recognition system; • be in a position to realize specific problems of automatic speech recognition.
(Study-Specific) Prerequisites	The module Automatic Speech Recognition must not be completed successfuly.
(recommended) Requirements	None.
References	Emphasis on signal processing and small-vocabulary recognition: • L. Rabiner, B. H. Juang: Fundamentals of Speech Recognition. Prentice Hall, Englewood Cliffs, NJ, 1993. Advanced topics: • D. Yu, L. Deng: Automatic Speech Recognition – A Deep Learning Approach. Springer, London, 2015.

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– Electives
– Elective Applied Computer Science
\+ Fundamentals of Automatic Speech Recognition (1230106)

Language	English
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	Priv.-Doz. Dr. Ralf Schlüter
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	-
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Fundamentals of Automatic Speech Recognition (123010601)	5th semester	no semester recommended	6	0
Exercises Fundamentals of Automatic Speech Recognition (123010602)	5th semester	no semester recommended	0	1

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Fundamentals of Automatic Speech Recognition	5th semester	no semester recommended	-	3

Module titel	Business Process Intelligence (Compulsory elective subject)
Identifier	1216958
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Summer semester 2018
Valid until	-
Module level	Bachelor/Master
Content	This course starts with an overview of approaches and technologies that use event data to support decision making and business process (re)design. Subsequently, the course focuses on process mining as a bridge between data mining and business process modeling. Business Process Intelligence (BPI) and process mining enable engineers to understand, diagnose, improve, and streamline operational processes for a wide variety of organizations and systems (production systems, hospitals, banks, high-tech systems, governments, electronic shops, transportation systems, trading systems, etc.). The course covers the three main types of process mining: process discovery, conformance checking, and enhancement. The course uses many examples using reallife event logs to illustrate the concepts and algorithms. After taking this course, one is able to run process mining projects and have a good understanding of the Business Process Intelligence (BPI) field. Moreover, students will be able to directly apply process mining techniques in all kinds of practical settings, including internships and master projects. | Written homework (DS Assignment 1) contains an analysis of a real-life and/or synthetic data set using the techniques and tools provided in the course. This homework is used to test the understanding of the material. Written homework (DS Assignment 2) contains an analysis of more complex data sets using various data science techniques. This includes interpreting the results and creatively using multiple views of the data. The written exam contains questions to test the theoretical knowledge of the algorithms and techniques learned.
Learning Objectives/ Learning Outcomes	Knowledge: On successful completion of this module, students should be able to: comprehend Petri nets, understand basic process discovery algorithms, understand how to align a process instance or an event log with a process model, being able to consider other perspectives e.g., performance projection on a Petri net and get familiar with concepts like responsible data science and big data in process mining. | Skills: Students should be able to use different process mining tools such as ProM and Disco. Moreover, they are able to filter event logs and understand how different parameters of an algorithm have an effect on the result of the analysis. | Competences: based on the knowledge and skills acquired during this course, students should be able to apply basic process mining algorithms on real industrial problems and answer related questions of business owners that are related to the process.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Prior knowledge in process modeling, logic, programming and databases.
References	The textbook "W. van der Aalst. Process Mining: Data Science in Action. Springer-Verlag, Berlin, 2016" (http://springer.com/9783662498507) is the primary source of information and the lectures will be linked to chapters in the book. Slides, exercises, software and data sets will be provided to participants. The Coursera MOOC on Process Mining https://www.coursera.org/learn/process-mining will provide additional background information in case things are not clear.
Language	English

– Electives
– Elective Data and Information Management
+ Business Process Intelligence (1216958)

Examination Terms	The module examination consists of the following partial qualifications: Written homework (40 %); Written exam (60 %). Students must pass all parts of the examination individually to pass the module. It is not possible to transfer parts of the examinations in another semester.
Miscellaneous	-
Module coordinator	Universitätsprofessor Professor h. c. Dr. h. c. Dr. ir. Wil van der Aalst
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	15-45 (mündlich/oral) | 90-120 (schriftlich/written)
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Business Process Intelligence (121695802)	6th semester	no semester recommended	0	2
Exam Business Process Intelligence (121695801)	6th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Business Process Intelligence	6th semester	no semester recommended	-	3

Module titel	Business Process Modeling & Computation (Compulsory elective subject)
Identifier	1229150
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2023
Valid until	-
Module level	Bachelor
Content	In this course, we will cover business process modelling (using BPMN) in an introductory fashion, and cover several computation methods on BPMN models in depth, such as flow analysis, queuing theory, stochastic process modelling, and simulation.
Learning Objectives/ Learning Outcomes	Knowledge: After successful completion of the module, students know a sizable part of the BPMN standard and several methods to assess the performance of business processes. Skills: After successful completion of this module, you'll be able to describe business processes using a formal process modelling language (BPMN), and to compute several properties of these models, such as the number of resources necessary to operate the process, the average time a customer will wait before being served or the cost of operating the process. Competences: Based on the knowledge and skills acquired in the module, students will be able to appreciate the quality of process models, to work in teams on complex computation tasks and to translate complex textual descriptions into formal process models.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Recommended prior knowledge includes logic, programming, algorithms and databases.
References	Fundamentals of Business Process Management, 2nd edition. Students are encouraged to personally assess their perceived necessity before purchasing the book.
Language	English
Examination Terms	The module examination consists of the following assessments: written assignment (50%); written exam (50%). Students must pass all assessments individually to pass the module. It is not possible to transfer parts of the examinations to another semester.
Miscellaneous	-
Module coordinator	Prof. Leemans
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	-

– Electives
– Elective Data and Information Management
+ Business Process Modeling & Computation (1229150)

Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Business Process Modelling & Computation (122915001)	3rd semester	no semester recommended	6	0
Exercise Business Process Modelling & Computation (122915002)	3rd semester	no semester recommended	0	2

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Business Process Modelling & Computation	3rd semester	no semester recommended	-	2

Module titel	Introduction to Web Technologies (Compulsory elective subject)
Identifier	1211914
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor
Content	The World Wide Web has a tremendous effect on the everyday life of people. Within just a few years, we have learned to use the Web for many different tasks, ranging from simple gathering of information to processing complex workflows. Thus the World Wide Web and its underlying technologies gain importance for the development of interactive Web applications. Today, lots of systems are developed in a mostly ad-hoc and unsystematic way, and the systems' quality is not assured. Although known methods from software engineering and for the design of information systems and distributed systems exist, these do not carry over easily to the development of Web applications. The course focuses on the combination of different methods and Web technologies; these will generally not be discussed in great detail, but instead exemplary presented and practiced. In other courses the underlying technologies may be studied in greater detail and with specific focuses (e.g. distributed systems, data communication, software engineering, eCommerce systems, information systems, hypermedia, human computer interaction, and eLearning). In this course the fundamental methods and technologies are combined and discussed in the context of small Web projects. We introduce some of the technologies and topics that are relevant for the development of Web applications.
Learning Objectives/ Learning Outcomes	Knowledge: Upon successful completion of this module, students should be able to explain the main concepts of fundamental Web technologies and Web standards; give an overview over and compare current Web technologies and how these can be combined in Web applications; describe problems and solutions for client-side programming by giving examples; illustrate problems and solutions for server-side technologies by giving examples in a self-chosen technology; name security risks and possible solutions in Web projects. | Skills: They should be able to analyze requirements of Web projects in order to evaluate and choose adequate Web technologies for implementing a small to medium sized Web application; combine several innovative Web technologies when designing innovative Web applications. | Competences: Based on the knowledge and skills acquired in this module, students will be able to scientifically communicate and discuss the main concepts of Web technologies; propose creative solutions in web projects; take responsibility in project work as a reliable project partner.
(Study-Specific) Prerequisites	- Gute Kenntnis der Konzepte der imperative und objektorientierten Programmierung - Kompetenzen mittelgroße Programme in kleinen Teams zu entwickeln. Voraussetzung für die Zulassung zur Prüfung ist das Beste-hen von Übungsaufgaben. Details werden in der Vorlesung bekanntgegeben.
(recommended) Requirements	Good knowledge of the concepts of imperative and object-oriented programming languages and techniques; in particular good knowledge in OO programming with Java. The ability to develop small and medium-sized programs.
References	Lecture notes with references
Language	German
Examination Terms	Written exam or oral examination (100 %)
Miscellaneous	-

– Electives
– Elective Data and Information Management
+ Introduction to Web Technologies (1211914)

Module coordinator	Universitätsprofessor Dr.-Ing. Ulrik Schroeder
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	15-45 (mündlich/oral) | 90-120 (schriftlich/written)
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Introduction to Web Technologies (121191402)	5th semester	no semester recommended	0	2
Exam Introduction to Web Technologies (121191401)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Introduction to Web Technologies	5th semester	no semester recommended	-	3

Module titel	Implementation of Databases (Compulsory elective subject)
Identifier	1215692
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	The module discusses the key aspects of the implementation of database systems. This includes an introduction of basic architectures (e.g. layered architecture) as well the procedures necessary for solving individual tasks (especially query processing and transaction management). The concepts of implementation will be applied to classical relational model as well as to more recent data models (distributed, object-oriented, deductive, search engines). In addition to the necessary theoretical background practical concepts will be introduced that allow database administrators the efficient tuning of databases.
Learning Objectives/ Learning Outcomes	Knowledge: Students will understand database architectures, query processing and optimization algorithms, transaction management concepts including recovery algorithms and their principles, and administration of databases. Competencies and skills: Students will be able to apply knowledge in these domains in practical problems of structuring a data management system, optimizing user queries, choosing appropriate concurrency control and recovery methods. In team exercises, students analyse and optimize database structures and functionalities, and present their handed-in solution in front of the class. Benefits for future professional life: Professional knowledge about evaluating, administrating and tuning existing databases as well as a solid understanding of information system architectures in modern businesses.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	None.
References	D.E. Shasha: Database Tuning - A Principled Approach. Prentice Hall, 1992 Elmasri, S. Navathe: Fundamentals of Database Systems, Addison-Wesley, 4. Aufl. 2003. T. Härder, E. Rahm: Datenbanksysteme – Konzepte und Techniken der Implementierung. Springer 1999. G. Vossen: Datenmodelle, Datenbanksprachen und Datenbank-Management-Systeme. Addison-Wesley, 4. Aufl. 2004.
Language	English
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. rer. pol. Matthias Jarke
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	15-45 (mündlich/oral) | 90-120 (schriftlich/written)

– Electives
– Elective Data and Information Management
+ Implementation of Databases (1215692)

Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Implementation of Databases (121569202)	5th semester	no semester recommended	0	1
Exam Implementation of Databases (121569201)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Implementation of Databases	5th semester	no semester recommended	-	3

Module titel	Artificial Intelligence (Compulsory elective subject)
Identifier	1215694
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	Agent Architecture, Heuristic Search, Games, Knowledge Representation, Baysian Networks, Machine Learning, Robotics.
Learning Objectives/ Learning Outcomes	Knowledge: Upon successful completion of this module, the student will be familiar with the basic methods underlying the design of intelligent agents, including search methods, knowledge representation using first-order logic, planning, reasoning under uncertainty, and inductive learning. | Skills: The student will be able to apply the methods taught in class to design intelligent agents him- or herself. | Competences: When developing large software systems, the student will be able to identify components and functionalities, which call for the use of Artificial Intelligence methods, and adapt and implement those methods for such purposes.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	None.
References	Lecture Notes (Transparencies); Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach (2nd Edition), Addison Wesley, 2002.
Language	English
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	Universitätsprofessor Gerhard Lakemeyer Ph. D.
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	15-45 (mündlich/oral) | 90-120 (schriftlich/written)
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

- Electives
- Elective Data and Information Management
+ Artificial Intelligence (1215694)

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Artificial Intelligence (121569402)	5th semester	no semester recommended	0	2
Exam Artificial Intelligence (121569401)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Artificial Intelligence	5th semester	no semester recommended	-	3

Module titel	The Logic of Knowledge Bases (Compulsory elective subject)
Identifier	1211393
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	First-Order Logic, The Modal Logic KL, Finite vs. Infinite representability, A Representation Theorem, Only Knowing, Autoepistemic Reasonining, Tractable Reasosoning, Situation Calculus
Learning Objectives/ Learning Outcomes	Knowledge: This lecture is about the logical foundations of knowledge bases. At the end of the course the student will able to characterize the functional view of knowledge bases, distinguish between the knowledge and symbol level, describe why epistemic query languages are needed in the presence of incomplete knowledge, reduce epistemic queries to first-order queries, appreciate the computational complexity inherent in incomplete information. | Skills: The student will be able to use modal logic to analyze the functional and computational requirements of knowledge-based systems, which need to deal with incomplete information. | Competences: The student will be able to play a leading role in the design team of knowledge-based systems.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Basic knowledge of Mathematical logic and/or knowledge representation or comparable knowledge.
References	Lecture Notes (Transparencies); Hector J. Levesque and Gerhard Lakemeyer, The Logic of Knowledge Bases, MIT Press, 2001.
Language	English
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	Universitätsprofessor Gerhard Lakemeyer Ph. D.
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	15-45 (mündlich/oral) | 90-120 (schriftlich/written)
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise The Logic of Knowledge Bases (121139302)	5th semester	no semester recommended	0	2
Exam The Logic of Knowledge Bases (121139301)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture The Logic of Knowledge Bases	5th semester	no semester recommended	-	3

Module titel	Knowledge Representation (Compulsory elective subject)
Identifier	1212361
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Master
Content	First-Order Logic, Resolution, Horn Logic, Procedural Representations, Description Logics, Inheritance Networks, Nonmonotonic Reasononing, Reasoning about Action and Planning
Learning Objectives/ Learning Outcomes	Knowledge: Upon successful completion of this module, the student will be familiar with the basic principles and methods of Knowledge Representation and Reasoning. These include first-order logic and inference by resolution, procedural representations, production systems, description logic, nonmonotonic reasoning, and abduction. | Skills: The student will be able to design knowledge-based systems. In particular, he or she will be able to analyze and cope with the computational complexity of such systems. | Competences: When developing software systems for large applications, the student will be able to identify which parts are best realized using a knowledge-based approach. Moreover, he or she will be able to choose among a number of existing methods to knowledge representation and reasoning and put the chosen methods to practice.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Knowledge of the lecture Mathematical Logic.
References	Lecture Notes (Transparencies; Ron Brachman and Hector J. Levesque, Knowledge Representation and Reasoning, Morgan Kaufmann, 2004.
Language	English
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the examination.
Miscellaneous	-
Module coordinator	Universitätsprofessor Gerhard Lakemeyer Ph. D.
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	15-45 (mündlich/oral) | 90-120 (schriftlich/written)
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

Knowledge Representation (1212361)

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Knowledge Representation (121236102)	6th semester	no semester recommended	0	2
Exam Knowledge Representation (121236101)	6th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Knowledge Representation	6th semester	no semester recommended	-	3

Module titel	Advanced Internet Technology (Compulsory elective subject)
Identifier	1215688
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	Introductory courses in communication systems deal with the classic communication principles of the Internet. These communication techniques are still in use, but are not able to cope with all the requirements of modern networks. This course gives an introduction into advanced communication paradigms that build upon the existing Internet technology: • Realizing scalable applications and communication: Peer-to-Peer systems and Cloud Computing • Integration of devices with restricted resources into the Internet: Cyber-physical Systems and the Internet of Things • Realization of adaptive communication: Software Defined Networking and Quality of Service
Learning Objectives/ Learning Outcomes	Knowledge: On successful completion of this module, students should be able to: • understand the restrictions of classical communication principles in the modern Internet • describe basic principles for realizing scalable, adaptive and resource constraint communication Skills: They should be able to: • identify sources of problems of classical communication protocols in modern communication systems • apply algorithms for scalable, adaptive and resource constraint communication Competences: Based on the knowledge and skills acquired they should be able to: • analyze the applicability of solutions for scalable, adaptive and resource constraint communication to future mobile Internet scenarios methodically • identify possibilities of evolving modern communication systems
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Basic knowledge in data communication and security is helpful.
References	• Vorlesungsfolien / Lecture Slides • Steinmetz, Wehrle (Eds.): Peer-to-Peer Systems and Applications, Springer, 2005 • Karl, Willig: Protocols and Architectures for Wireless Sensor Networks, Wiley, 2005 • Weitere Spezialliteratur wird in den Vorlesungsfolien bekannt gegeben
Language	English
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-

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– Electives
– Elective Software and Communication
+ Advanced Internet Technology (1215688)

Module coordinator	Universitätsprofessor Dr.-Ing. Klaus Wehrle
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	15-45 (mündlich/oral) | 90-120 (schriftlich/written)
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Advanced Internet Technology (121568802)	5th semester	no semester recommended	0	1
Exam Advanced Internet Technology (121568801)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Advanced Internet Technology	5th semester	no semester recommended	-	3

Module titel	Communication Systems Engineering (Compulsory elective subject)
Identifier	1212349
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	This lecture addresses the foundations and technologies required in the engineering of modern communication systems: • Protocol Design: basic methods for designing communication protocols • ;Implementation: tools and technologies for implementing communication systems in both kernel space and user space • Verification and Testing: approaches to ensure the correct behavior of a protocol implementation • Evaluation by discrete event simulation (modeling, validation, parameter studies) • Internet-scale evaluation by measurements.
Learning Objectives/ Learning Outcomes	Knowledge: On successful completion of this module, students should be able to: • understand the foundations of protocol engineering • describe the different concepts of performance evaluation Skills: They should be able to: • analyze the results of a performance evaluation study • propose enhancements for existing communication systems Competences: • Based on the knowledge and skills acquired they should be able to: • design and develop novel communication systems and evaluate their performance.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Basic knowledge in data communication and operating systems. Knowledge in C/C++ are helpful.
References	Lecture slides; within the slides further literature is cited.
Language	English
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr.-Ing. Klaus Wehrle & Dr. rer. nat. Dirk Thißen
ECTS Credits	6

– Electives
– Elective Software and Communication
+ Communication Systems Engineering (1212349)

Contact time (WSH)	4
Examination duration (min)	15-45 (mündlich/oral) | 90-120 (schriftlich/written)
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Communication Systems Engineering (121234901)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture/Exercises Communication Systems Engineering	5th semester	no semester recommended	-	4

Module titel	Embedded Systems (Compulsory elective subject)
Identifier	1215690
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	Embedded systems control many things in our daily life. Energy-efficient refrigerators, elevator controls, and advanced driver assistance systems are just some examples. Embedded systems also control processes in industrial environments and are used to detect and prevent system failures. This lecture gives a general introduction to the topic of embedded systems. It introduces basic concepts and points out important differences to “normal” computer systems. This lecture prepares students for advanced lectures of the Embedded Software Laboratory that cover safety, reliability, formal methods and dynamic systems in detail. This lecture is targeted at all students that do not want to limit themselves to understanding PCs but also want to know how, for example, engine control units and production control systems work. Topics covered in this lecture are: Microcontroller, Programmable logic controllers (PLCs, PLC programming languages, Real-time requirements, Real-time operating systems, Characteristics of embedded software design, Intra vehicle communication (e.g., CAN bus), Teasers of advanced lectures of the embedded software laboratory, The lecture will be held in German with English slides.
Learning Objectives/ Learning Outcomes	Knowledge: Knowledge and confidence in modern software techniques for embedded systems | Skills: Ability to apply a model-based quality-oriented approach for the design of embedded software | Competences: Sensibility for special qualitative requirements for the design of embedded software
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Knowledge of “Foundations of Technical Computer Science”.
References	Slides of the lecture, script and the following books: Marwedel: Eingebettete Systeme. 2003 | Bass, Clements: Software Architecture in Practice. | Douglass: Real-time UML
Language	English
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr.-Ing. Stefan Kowalewski
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	15-45 (mündlich/oral) | 90-120 (schriftlich/written)
Total hours (h)	180,0

– Electives
– Elective Software and Communication
+ Embedded Systems (1215690)

Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Embedded Systems (121569002)	6th semester	no semester recommended	0	1
Exam Embedded Systems (121569001)	6th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Embedded Systems	6th semester	no semester recommended	-	3

Module titel	Mobile Internet Technology (Compulsory elective subject)
Identifier	1212346
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Summer semester 2018
Valid until	-
Module level	Bachelor/Master
Content	This course addresses architectures, protocols, and algorithms for mobile Internet systems: • Physical layer: modulation, coding and signal propagation • MAC layer: challenges in wireless medium access • Wireless, data-oriented networks: 802.11 (WLAN) • Routing in Ad-hoc networks • Mobile networks: GSM, GPRS, UMTS, LTE, 5G • Mobility in the Internet: Mobile IP, HIP, TCP
Learning Objectives/ Learning Outcomes	Knowledge: On successful completion of this module, students should be able to: • describe the principles of wireless networks, especially 802.11 (WLAN) and telecommunication networks • state problems of the Internet protocols (IP, TCP) in mobile scenarios Skills: They should be able to: • use the gained knowledge to identify sources of problems in mobile scenarios and to deal with them appropriately • ;identify important common aspects in wireless network approaches Competences: Based on the knowledge and skills acquired they should be able to: • analyze the applicability of mobile system architectures for future mobile Internet scenarios methodically • discuss requirements to the Internet protocols in wireless systems and propose solutions how to fulfil these requirements
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Basic knowledge in data communication is recommended
References	• Folien zur Vorlesung / Lecture Slides • J. Schiller: Mobile Communications, 2. Auflage, Addison Wesley, 2004 • W. Stallings: "Wireless Communications and Networks&;quot;. Pearson, 2nd Ed., 2014 • Weitere Spezialliteratur wird in den Vorlesungsfolien bekannt gegeben
Language	English
Examination Terms	Written exam or oral examination (100%). Students must pass written homework to be admitted to the module examination.

Miscellaneous	-
Module coordinator	Universitätsprofessor Dr.-Ing. Klaus Wehrle & Dr. rer. nat. Dirk Thißen
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	15-45 (mündlich/oral) | 90-120 (schriftlich/written)
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Mobile Internet Technology (121234602)	6th semester	no semester recommended	0	1
Exam Mobile Internet Technology (121234601)	6th semester	no semester recommended	6	0

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Mobile Internet Technology	6th semester	no semester recommended	-	3

Module titel	Model-Based Software Engineering (Compulsory elective subject)
Identifier	1215686
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	After an introduction of UML, the possibilities of using models in the software development process are discussed. These include simulation, code and test case generation, analysis, modeling and evolution of systems by refactoring of models. Topics: UML, Use of models in the software engineering process, Simulation, code and test generation, Analysis of models, Evolution of models by refactoring.
Learning Objectives/ Learning Outcomes	Understanding of the use of models, Application of models in software engineering, Knowledge and practicing of UML
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Knowledge of “Software Engineering”.
References	B. Rumpe: Modellierung mit UML : Sprache, Konzepte und Methodik, Springer, 2016, B. Rumpe : Agile Modellierung mit UML : Codegenerierung, Testfälle, Refactoring. Springer, 2017
Language	German/English
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. rer. nat. Bernhard Rumpe
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	15-45 (mündlich/oral) | 90-120 (schriftlich/written)
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Model-Based Software Engineering (121568602)	5th semester	no semester recommended	0	3
Exam Model-Based Software Engineering (121568601)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Model-Based Software Engineering	5th semester	no semester recommended	-	2

Module titel	Software Language Engineering (Compulsory elective subject)
Identifier	1216957
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	"The limits of my language are the limits of my world." Ludwig Wittgenstein. This is all the more true when people communicate with computers. The course deals with concepts of language definition, such as meta-models, grammars, modern editors and the use of software languages, for example for modeling software, systems, and simulations. It discusses examples such as UML, domain-specific languages (DSL) and XML, as well as semantic analysis and generation techniques. DSLs are always useful and often necessary where non-computer scientists have to deal with computers and have to model complex facts, scenarios or systems. DSL models are suited for modelling the human brain, automous cars, E-home components. They allow to generate code or orchestrate business processes in the cloud, and much more.
Learning Objectives/ Learning Outcomes	Knowledge • Domain-specific languages • Generator technology • Simulation and generation from models • Analysis of models Skills &; Competences • Development of own DSLs • Understanding the usability of a language workbench • Understanding the use of DSLs for development and simulation of systems
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Knowledge from Introduction to Software Engineering.
References	• [Rum17] B. Rumpe: Agile Modeling with UML: Code Generation, Testing, Refactoring. Springer International, May 2017. • [CFJ+16] B. Combemale, R. France, J. Jézéquel, B. Rumpe, J. Steel, D. Vojtisek: Engineering Modeling Languages: Turning Domain Knowledge into Tools. Chapman &; Hall/CRC Innovations in Software Engineering and Software Development Series, November 2016.
Language	German/English
Examination Terms	Project work (100 %).
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Modulangebotsverantwortlicher InformatikModellierungsteamverantwortlicher: Dr. rer. nat. Katja PetzoldtModulverantworlicher: Universitätsprofessor Dr. rer. nat. Bernhard Rumpe

+ Software Language Engineering (1216957)

ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	0
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Software Language Engineering (121695702)	6th semester	no semester recommended	0	3
Exam Software Language Engineering (121695701)	6th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Software Language Engineering	6th semester	no semester recommended	-	2

Module titel	Software Architectures (Compulsory elective subject)
Identifier	1215687
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Summer semester 2018
Valid until	-
Module level	Bachelor/Master
Content	• Modeling at design level • A module concept • Subarchitectures and extensions of the module concept • Transformation into programming languages • Architecture examples • Strategies for adaptability and reusability • Expressing semantics • Expressing distribution • Concurrent &; embedded systems • Concrete and abstract component connections
Learning Objectives/ Learning Outcomes	• Object-based and object-oriented architecture modeling • Integrating Approach including locality, layering, inheritance • Studying of big examples for transformation systems, interactive systems, and embedded systems • Approach also applicable for integration aspects in reverse engineering, embedded systems
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Knowledge of 'Introduction to Software Engineering'
References	• M. Nagl: Methodisches Programmieren 1990 • weitere schriftliche Unterlagen • andere Lehrbücher zur Ergänzung
Language	German/English
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the examination.
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Modulangebotsverantwortlicher InformatikModellierungsteamverantwortlicher: Dr. rer. nat. Katja PetzoldtModulverantworlicher: Universitätsprofessor i.R. Dr.-Ing. Manfred Nagl
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	0

– Electives
– Elective Software and Communication
+ Software Architectures (1215687)

Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Software Architectures (121568702)	6th semester	no semester recommended	0	2
Exam Software Architectures (121568701)	6th semester	no semester recommended	6	0

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Software Architectures	6th semester	no semester recommended	-	3

Module titel	Advanced Automata Theory (Compulsory elective subject)
Identifier	1211981
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	irregularly
Valid from	Summer semester 2018
Valid until	-
Module level	Bachelor/Master
Content	• the minimization problem for nondeterministic automata • connection of automata and logic • automata on finite trees • algorithms for infinite transition systems • basic undecidability results in automata theory
Learning Objectives/ Learning Outcomes	Knowledge: The students learn about extended automaton models and their properties. Skills: The students are able to judge the expressiveness and algorithmic complexity of a model from its basic properties. Competences: The students are able to work with state based models in computer science.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Knowledge from the following areas is expected: 'Formal Systems, Automata and Processes', 'Computability and Complexity', 'Mathematical Logic'.
References	-
Language	German
Examination Terms	Written exam (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	Dr. rer. nat. Christof Löding
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	0
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercises Advanced Automata Theory (121198102)	5th semester	no semester recommended	0	2
Exam Advance Automata Theory (121198101)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Advanced Automata Theory	5th semester	no semester recommended	-	3

Algorithmic Foundations of Datascience (1216860)

Module titel	Algorithmic Foundations of Datascience (Compulsory elective subject)
Identifier	1216860
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Summer semester 2021
Valid until	-
Module level	Bachelor/Master
Content	The course is an introduction to a wide range of algorithmic techniques that are used in data science, with a focus on mathematical and theoretical aspects such as a careful complexity analysis. Starting with mathemtical foundations from probability theory, information theory, and linear algebra, the course covers typical algorithmic techniques for data analysis tasks as well as typical algorithmic techniques applied in big-data scenarios, such as streaming algorithms and algorithms for compute clusters.
Learning Objectives/ Learning Outcomes	A broad spectrum of data-science algorithms and their mathemtical foundations. Skills: Theoretical understanding of algorithmic efficiency and complexity in typical data-science scenarios. Techniques for analysisng algorithms in this area. Competence: Ability to choose suitable algorithms in different data science scenarios and understand the implications of these choices.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Mathematical foundations from linear algebra and probability theory. Computer science foundations from data structures and algorithms, computability and complexity, and database systems.
References	-
Language	English
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the examination.
Miscellaneous	-
Module coordinator	-
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	-
Total hours (h)	180,0

Algorithmic Foundations of Datascience (1216860)

Contact hours (h)	75,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Algorithmic Foundations of Datascience (121686002)	5th semester	no semester recommended	0	2
Exam Algorithmic Foundations of Datascience (121686001)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Algorithmic Foundations of Datascience	5th semester	no semester recommended	-	3

Module titel	Algorithmic Model Theory I (Compulsory elective subject)
Identifier	1113583
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	irregularly
Valid from	Winter semester 2018
Valid until	-
Module level	Master
Content	Entscheidbare und unentscheidbare Theorien, Logik und Automaten, monadische Theorien, Prädikatenlogik auf endlichen Strukturen, Lokalität und Ehrenfeucht-Fraisse-Spiele, Fixpunktlogiken, TC Logiken, Logische Charakterisierung von Komplexitätsklassen, Interpretationen, automatische Strukturen, endlich präsentierbare Strukturen
Learning Objectives/ Learning Outcomes	Verständnis der Zusammenhänge von logischer Definierbarkeit und algorithmischer Komplexität (Entscheidbarkeit von Theorien, Auswertungsalgorithmen, logische Charakterisierungen von Komplexitätsklassen). Beherrschen der modelltheoretischen und algorithmischen Methoden zur Analyse der Ausdrucksstärke und Komplexität logischer Spezifikationen auf endlichen und endlich präsentierbaren Strukturen. Fähigkeit, mit den fundamentalen Logiken der algorithmischen Modelltheorie umzugehen und diese in konkreten Szenarien anzuwenden.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Teilnahmebedingungen: Kenntnisse des Moduls Mathematische Logik I
References	Skript zur Vorlesung; H.-D. Ebbinghaus, J. Flum, Finite Model Theory, Springer 1995; E. Grädel et al., Finite Model Theory and its Applications, Springer 2006; N. Immerman, Descriptive Complexity, Springer 1999; L. Libkin, Elements of Finite Model Theory, Springer 2004
Language	German/English
Examination Terms	Zulassungsvoraussetzung: Lösen von Übungsaufgaben Prüfungsleistung: Bestehen einer Klausur oder einer mündlichen Prüfung; Prüfungsdauer und -art werden am Anfang des Semesters bekannt gegeben
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. phil. Erich Grädel
ECTS Credits	9
Contact time (WSH)	6
Examination duration (min)	-

– Electives
– Elective Theoretical Computer Science
+ Algorithmic Model Theory I (1113583)

Total hours (h)	270,0
Contact hours (h)	90,0
Self-study hours (h)	180,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Algorithmic Model Theory I (111358302)	5th semester	no semester recommended	0	2
Examination: Algorithmic Model Theory I (111358301)	5th semester	no semester recommended	9	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Algorithmic Model Theory I	5th semester	no semester recommended	-	4

Module titel	Compiler Construction (Compulsory elective subject)
Identifier	1211978
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	• Lexical analysis of programs (Scanner) • Syntactical analysis of programs (Parser) • Semantic analysis • Tools for compiler construction (lex, yacc)
Learning Objectives/ Learning Outcomes	Acquisition of the following knowledge, skills and competences: • Understanding of the construction and working principles of compilers for higher programming languages • Knowledge on methods of formalizing syntax (regular expressions, context-free and attribute grammars, EBNF) • Ability to implement simple compiler components (Scanner, Parser) • Knowledge in applying compiler-generating tools
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Mastering the essential concepts of imperative and object-oriented programming languages as well as elementary programming techniques in these languages (Modul Programmierung). Knowledge of data structures like lists, stacks, queues and trees (Modul Datenstrukturen und Algorithmen). Knowledge of basic automata models like finite automata and pushdown automata (Modul Formale Systeme, Automaten und Prozesse).
References	Folien und Skripte zur Vorlesung sowie folgende Lehrbücher: • A. Aho, R. Sethi, J. Ullman: Compilers – Principles, Techniques, and Tools. Addison-Wesley, 1988. • A.W. Appel, J. Palsberg: Modern Compiler Implementation in Java. Cambridge University Press, 2002. • D. Grune, H.E. Bal, C.J.H. Jacobs, K.G. Langendoen: Modern Compiler Design. Wiley &; Sons, 2000. • R. Wilhelm, D. Maurer: Übersetzerbau, 2. Auflage. Springer, 1997.
Language	German
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Modulangebotsverantwortlicher InformatikModellierungsteamverantwortlicher: Dr. rer. nat. Katja PetzoldtModulverantworlicher: apl. Professor Dr. rer. nat. Thomas NollUniversitätsprofessor Dr. ir. Dr. h. c. (AAU) Joost-Pieter Katoen
ECTS Credits	6

Contact time (WSH)	5
Examination duration (min)	0
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercises Introduction to Compiler Construction (121197802)	6th semester	no semester recommended	0	2
Exam Introduction to Compiler Construction (121197801)	6th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Introduction to Compiler Construction	6th semester	no semester recommended	-	3

+ Discrete and Combinatorial Optimization (8014214)

Module titel	Discrete and Combinatorial Optimization (Compulsory elective subject)
Identifier	8014214
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Winter semester 2024
Valid until	-
Module level	Bachelor
Content	Minimum Spanning Tree, Matchings in allgemeinen Graphen, Grundlagen Approximationsalgorithmen, Grundlagen der ganzzahligen Optimierung, Grundlagen und Algorithmen des Maschinellen Lernens
Learning Objectives/ Learning Outcomes	Aufbauend auf den in der Veranstaltung “Lineare Optimierung und Netzwerkalgorithmen” gewonnenen Kenntnissen sollen die Studierenden in dieser Veranstaltung ein tiefergehendes Verständnis der Modelle und Algorithmen aus der diskreten und kombinatorischen Optimierung erwerben. Die Studierenden sollen lernen, Algorithmen für diskrete und kombinatorische Optimierungsprobleme zu verstehen und zu analysieren, sowie Optimierungsproblemen aus der Praxis als abstrakte, gut verstandende, mathematische Probleme der diskreten und kombinatorischen Optimierung zu formulieren.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Kenntnis der Inhalte der Veranstaltung Lineare Optimierung und Netzwerkalgorithmen
References	Skript zur Vorlesung, Unterrichtsmaterialien
Language	German/English
Examination Terms	Zulassungsvoraussetzung: Lösen von Übungsaufgaben, Prüfungsleistung: Bestehen einer Klausur oder einer mündlichen Prüfung (benotet); Prüfungsdauer und - art werden zu Beginn der Lehrveranstaltung bekannt gegeben.
Miscellaneous	-
Module coordinator	Univ. Prof. Dr. Ir. Arie M.C.A. Koster, Univ. Prof. Dr. rer. nat. Britta Peis, Univ. Prof. Dr. rer. nat. Christina Büsing
ECTS Credits	9
Contact time (WSH)	6
Examination duration (min)	0
Total hours (h)	270,0
Contact hours (h)	90,0
Self-study hours (h)	180,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Discrete and Combinatorial Optimization (Examination) (801421401)	4th semester	no semester recommended	9	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Discrete and Combinatorial Optimization (Lecture)	4th semester	no semester recommended	-	4
Discrete and Combinatorial Optimization (Exercise Unit)	4th semester	no semester recommended	-	2

Module titel	Dynamical Processes on Networks (Compulsory elective subject)
Identifier	1223640
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Summer semester 2021
Valid until	-
Module level	Bachelor/Master
Content	Many real-world systems may be described as a network of dynamically interacting entities. We interact with each other in a social contact network, over which rumours as well as pathogens cam spread; electrical energy is delivered by the power grid; the Internet enables almost instantaneous world-wide interactions; our economies rest upon a complex network of inter-dependencies spanning the globe. Networks are ubiquitous in complex biological, social, engineering, and physical systems. Understanding the dynamics of these systems is essential if we are to redesign them, or guide/control them towards different behaviours. Networked control problems abound and include multi-user communication, distributed computation and sensing, swarming, flocking, and synchronization. This course provides a (mathematical) introduction to such network dynamical systems. We discuss a selection of fundamental dynamical phenomena over interconnected network systems, e.g., consensus and disagreement in averaging systems, epidemic spreading dynamics, opinion formation models and synchronization of coupled oscillators and networked control systems.
Learning Objectives/ Learning Outcomes	This course will provide students with the mathematical tools and computational training to understand large-scale dynamical networks. Knowledge • Students will be familiar with typically considered distributed dynamical systems on networks. • These include linear processes such as consensus dynamics &; distributed averaging, network diffusion models &; opinion formation models, and nonlinear processes such as epidemic spreading (SI,SIS,SIR) and synchronization processes. Skills • After taking this course the students will be able to model a variety of systems as networks. • Students will be able to analyse key features of the dynamics of such dynamical network systems, using algebraic graph theory and relate (structural) properties of the network to observed dynamical behaviours. They will further be able to simulate and analyse the dynamics of such systems using python code. Competences • Students will be able to use networks as a language to communicate across different application domains and be able to analyze and implement simple models for network dynamics across a variety of domains.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Knowledge of Linear Algebra Knowledge of basic Probability Knowledge of basic Graph Theory Knowledge of Python (optional) Some prior experience with dynamical systems

– Electives
– Elective Theoretical Computer Science
+ Dynamical Processes on Networks (1223640)

References	F. Bullo, "Lectures on Network Systems", 2020, available online at http://motion.me.ucsb.edu/book-lns/ Additional material will be provided in the form of slides and research papers.
Language	English
Examination Terms	Written exam or oral examination (100%). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	-
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	-
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Dynamical Processes on Networks (122364001)	5th semester	no semester recommended	6	0
Exercise Dynamical Processes on Networks (122364002)	5th semester	no semester recommended	0	2

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Dynamical Processes on Networks	5th semester	no semester recommended	-	3

Module titel	Efficient Algorithms (Compulsory elective subject)
Identifier	1211977
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	Algorithms for maximum flow and matchings Introduction to linear programming • Simplex method • Ellipsoid method • Duality Methods and techniques to deal with hard problems • Approximation algorithms • Parametrized algorithms • Heuristic approaches Introduction to randomized algorithms Introduction to online algorithms
Learning Objectives/ Learning Outcomes	• Overview of state-of-the-art algorithms • Knowledge of advanced methods from algorithm design and analysis • Knowledge about techniques to deal with hard optimization problems • Basic knowledge about randomized algorithms and online algorithms
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Content of the lectures "Datenstrukturen und Algorithmen" and "Berechenbarkeit und Komplexität".
References	Zur Vorlesung wird ein Skript erstellt und folgende Literatur empfohlen: • T. Cormen, C. Leiserson, R. Rivest, C. Stein: Introduction to Algorithms, 2nd Edition, MIT Press and McGraw-Hill, 2001 • J. Kleinberg, E. Tardos: Algorithm Design, Addison-Wesley, 2004. • C. Papadimitriou, K. Steiglitz: Combinatorial Optimization: Algorithms and Complexity, Dover Publications, Inc., 1998. • V. Vazirani, Approximation Algorithms, Springer, 2001. • R. Motwani, P. Raghavan. Randomized Algorithms, 1996.
Language	German
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Modulangebotsverantwortlicher InformatikModellierungsteamverantwortlicher: Dr. rer. nat. Katja PetzoldtModulverantworlicher: Universitätsprofessor Dr. rer. nat. Peter RossmanithDr. rer. nat. Walter Unger
ECTS Credits	6
Contact time (WSH)	5

- Electives
- Elective Theoretical Computer Science
+ Efficient Algorithms (1211977)

Examination duration (min)	0
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercises Introduction to Efficient Algorithms (121197702)	6th semester	no semester recommended	0	2
Exam Introduction to Efficient Algorithms (121197701)	6th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Vorlesung Introduction to Efficient Algorithms	6th semester	no semester recommended	-	3

Module titel	Satisfiability Checking (Compulsory elective subject)
Identifier	1212341
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	- Propositional logic, the satisfiability problem - SAT-solving for checking the satisfiability of propositional logic formulas - First-order logic, theories - Satisfiability modulo theories (SMT) solving - SMT solving for the theory of equalities and uninterpreted functions - SMT solving for bit-vector arithmetic - SMT solving for linear real arithmetic - SMT solving for linear integer arithmetic - SMT solving for (non-linear) real arithmetic - Applications
Learning Objectives/ Learning Outcomes	Knowledge: In this lecture the students will learn to differentiate between different first-order theories and get insight into corresponding decidability and complexity results. The lecture will show them how satisfiability checking algorithms check formulas from those logics for satisfiability. Skills: The students will practice to formalize problems in adequate logics and to apply satisfiability checking procedures to solve them. Especially, they will know which solvers are available and can use these e.g. for verification and counterexample generation. Competences: The students will improve their competences for the development and application of decision procedures. They will be able to decide when they can use these methods to solve problems from different areas of computer science. In the lecture they will improve the exact communication of scientific problems. The lecture will also increase their motivation for the application of formal methods.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Knowledge from the modules "Mathematical logic", as well as "Algorithms and data structures".
References	Lecture slides and the following books: • Daniel Kroening, Ofer Strichman: Decision Procedures: An Algorithmic Point of View. Springer Berlin, 2008 • Aaron R. Bradley, Zohar Manna: The Calculus of Computation: Decision Procedures with Applications to Verification. Springer, Berlin. 2007
Language	English
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	Universitätsprofessorin Dr. Erika Ábrahám

– Electives
– Elective Theoretical Computer Science
+ Satisfiability Checking (1212341)

ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	0
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercises Satisfiability Checking (121234102)	5th semester	no semester recommended	0	1
Exam Satisfiability Checking (121234101)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Satisfiability Checking	5th semester	no semester recommended	-	3

Module titel	Foundations of Functional Programming (Compulsory elective subject)
Identifier	1215684
Version	V3
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2023
Valid until	-
Module level	Bachelor/Master
Content	Introduction to the programming language Haskell • syntax of the different language constructs • higher-order functions • programming with lazy evaluation • monads Denotational semantics of functional programs • complete partial orders and fixpoints • denotational semantics of Haskell Lambda calculus • syntax and operational semantics of the lambda calculus • reducing Haskell to the lambda calculus Type checking and inference
Learning Objectives/ Learning Outcomes	Knowledge: learning the foundational concepts behind functional languages Skills: • learning the programming techniques in functional languages • learning how to formally define the semantics of functional programming languages • learning how to implement functional languages • learning how to develop type checking techniques for functional languages Competences: learning how to use functional languages in different application areas
(Study-Specific) Prerequisites	-
(recommended) Requirements	Basic programming concepts. Prior knowledge on functional programming would be advantageous, but is not required.
References	Course notes and transparencies, as well as the following literature: • R. Bird: Thinking Functionally With Haskell, Cambridge University Press, 2014. • G. Hutton: Programming in Haskell, Cambridge University Press, 2016. • B. O'Sullivan, D. Stewart, J. Goerzen: Real World Haskell, O'Reilly, 2010. • P. Pepper: Funktionale Programmierung, Springer, 2002. • C. Reade: Elements of Functional Programming, Addison-Wesley, 1989. • P. Thiemann: Grundlagen der Funktionalen Programmierung, Teubner, 1994.
Language	English

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+ Foundations of Functional Programming (1215684)

Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Modulangebotsverantwortlicher InformatikModellierungsteamverantwortlicher: Dr. rer. nat. Katja PetzoldtModulverantworlicher: Universitätsprofessor Dr. rer. nat. Jürgen Giesl
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	-
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Foundations of Functional Programming (121568402)	6th semester	no semester recommended	0	2
Exam Foundations of Functional Programming (121568401)	6th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Foundations of Functional Programming	6th semester	no semester recommended	-	3

+ Foundations of Logic Programming (1212343)

Module titel	Foundations of Logic Programming (Compulsory elective subject)
Identifier	1212343
Version	V3
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2023
Valid until	-
Module level	Bachelor/Master
Content	Basics of predicate logic • unification • resolution • Horn clauses and SLD-resolution Logic programs • operational and denotational semantics • evaluation strategies The programming language Prolog • negation-as-failure • non-logical components of Prolog • programming techniques Applications and extensions of logic programming
Learning Objectives/ Learning Outcomes	Knowledge: learning the concepts and the foundations of logic languages. Skills: • learning the programming techniques in logic programming languages • learning how to formally define the semantics of logic programming languages • learning how to implement logic languages Competences: learning how to use logic languages in different application areas
(Study-Specific) Prerequisites	-
(recommended) Requirements	Basic programming concepts. Prior knowledge on logic programming would be advantageous, but is not required. Prior knowledge on predicate logic would be advantageous, but is not required.
References	Course notes and transparencies, as well as the following literature: • I. Bratko: Prolog Programming for Artificial Intelligence, Addison-Wesley, 2011. • W. F. Clocksin, C. S. Mellish: Programming in Prolog, Springer, 2013. • T. Früwirth, S. Abdennadher: Essentials of Constraint Programming, Springer, 2010. • M. Hanus: Problemlösen mit Prolog, Teubner, 1987. • J. W. Lloyd: Foundations of Logic Programming, Springer, 2013. • P. H. Schmitt: Theorie der logischen Programmierung, Springer, 1992. • L. Sterling, E. Shapiro: The art of Prolog, MIT Press, 2000.
Language	English

Foundations of Logic Programming (1212343)

Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Modulangebotsverantwortlicher InformatikModellierungsteamverantwortlicher: Dr. rer. nat. Katja PetzoldtModulverantworlicher: Universitätsprofessor Dr. rer. nat. Jürgen Giesl
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	-
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Foundations of Logic Programming (121234302)	6th semester	no semester recommended	0	2
Exam Foundations of Logic Programming (121234301)	6th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Foundations of Logic Programming	6th semester	no semester recommended	-	3

Module titel	Introduction to Algorithmic Differentiation (Compulsory elective subject)
Identifier	1221327
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2021
Valid until	-
Module level	Bachelor/Master
Content	We discuss the algorithmic differentiation of differentiable numerical programs, that is the generation of first-, second- and higher-order tangent and adjoint code by • operator and function overloading in C++ • manual source transformation • automatic source transformation
Learning Objectives/ Learning Outcomes	• Knowledge: understanding of fundamental algorithmic differentiation (AD) modes • Skills: ability to apply AD software to differentiable numerical programs • Competences: choice of appropriate AD mode for a given task
(Study-Specific) Prerequisites	-
(recommended) Requirements	• Introduction to Programming • Introduction to Calculus
References	• Set of slides • Example programs • Naumann: The Art of Differentiating Computer Programs. SIAM 2012. • Griewank, Walther: Evaluating Derivatives. SIAM 2008. • References to relevant current literature and online materials
Language	English
Examination Terms	Written exam (100 %).
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. rer. nat. Uwe Naumann
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	120
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Introduction to Algorithmic Differentiation (122132702)	5th semester	no semester recommended	0	1
Exam Introduction to Algorithmic Differentiation (122132701)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Introduction to Algorithmic Differentiation	5th semester	no semester recommended	-	3

Module titel	Introduction to Quantum Computing (Compulsory elective subject)
Identifier	1230246
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Summer semester 2024
Valid until	-
Module level	Bachelor/Master

Content	What are quantum computers? Are they magic computers that can compute everything faster? Or are they some science-fiction that has nothing to do with reality? How do they work? What can they do? In this lecture, we will introduce the basics of quantum computing from the computer science perspective. We will understand how quantum mechanics allows us to compute some problems faster (and some not), how to program a quantum computer, and what the challenges are. There will be a mix of mathematical foundations, and applied quantum computer programming.
	
	Content:
	
	• Mathematical foundations of quantum mechanics
	• How do quantum computers work?
	• How are quantum computers built? (Physical implementations.)
	• Why are quantum computers difficult (problems with noise)
	• Programming a quantum computer (Writing your own quantum programs.)
	• Quantum algorithms:
	    • Simple basic algorithms
	    • Grover's algorithm ("database" search)
	    • Shor's algorithm (factoring, etc.)
	    • Possibly more
	• Quantum simulation (simulating physical processes with a quantum computer)
	• The course comes with both theory and with programming exercises, to run on simulated (or real) quantum computers.

Learning Objectives/ Learning Outcomes	Knowledge: After successful completion of the module students know: • the basic mathematics of quantum computing • how quantum computers work • how quantum computers are built • how the most important quantum algorithms work • what the problems are with building quantum computers • how quantum computers are programmed • how quantum computers relate to the simulation of physical systems Skills: After successful completion of the module, students will be able to: • compute what a quantum program does (on paper) • program quantum computers (simple programs) • understand research papers introducing quantum algorithms • understand why quantum computers cannot just do everything faster Competencies: Based on the knowledge and skills acquired in the module, students will be able to: • understand claims about quantum computers (recognize obvious nonsense) • put modern developments in quantum computing into context • follow advanced quantum computing related courses • join projects working on the software-side of quantum computing
(Study-Specific) Prerequisites	None

(recommended) Requirements	None.
References	-
Language	English
Examination Terms	Written exam (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	Univ.-Prof. Dr. rer. nat. Dominique Unruh
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	-
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Introduction to Quantum Computing (123024601)	6th semester	no semester recommended	6	0
Excercise Introduction to Quantum Computing (123024602)	6th semester	no semester recommended	0	2

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Introduction to Quantum Computing	6th semester	no semester recommended	-	3

Module titel	Module Complexity Theory (Compulsory elective subject)
Identifier	1212331
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	Deterministic, nondeterministic, probablistic, and parallel computation models; complexity classes; reductions; selection of advanced topics such as inetractive proofs, derandomisation, circuit complexity, communication complexity, parameterized complexity.
Learning Objectives/ Learning Outcomes	Knowledge: - Advanced knowledge in core areas of complexity theory Skills: - The ability to classify computational problems according to their computational complexity - The ability to analyse the relation between complexity classes. Competence: - A deeper understanding of the most important complexity classes and complexity measures and the interplay between different aspects of computational complexity.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Mathematical foundations from discrete mathematics and linear algebra. Computer science foundations from data structures and algorithms, computability and complexity.
References	Arora, Barak: Computational Complexity – A Modern Approach; Papadimitriou: Computational Complexity; Wegener: Komplexitätstheorie
Language	English
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Modulangebotsverantwortlicher InformatikModellierungsteamverantwortlicher: Dr. rer. nat. Katja PetzoldtModulverantworlicher: Universitätsprofessor Dr. rer. nat. Martin Grohe
ECTS Credits	6
Contact time (WSH)	5

Examination duration (min)	90
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Complexity Theory (121233102)	5th semester	no semester recommended	0	2
Exam Complexity Theory (121233101)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Complexity Theory	5th semester	no semester recommended	-	3

Module titel	Machine Learning with Graphs: Foundations and Applications (Compulsory elective subject)
Identifier	1227996
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Summer semester 2023
Valid until	-
Module level	Master
Content	Graph-structured data is ubiquitous across application domains ranging from chemo- and bioinformatics to image and social network analysis. To develop successful machine learning algorithms, we need techniques that map the rich information inherent in the graph structure to a vectorial representation in a meaningful way—often called graph embeddings. Roughly, the first two-thirds of this class offers an overview of recent results shedding light on graph embeddings' theoretical properties, i.e., their expressivity and generalization performance, focusing on graph neural networks. In the last third, the course overviews interesting applications of graph embeddings, e.g., the prediction of molecular properties or their use in combinatorial optimization. ;
Learning Objectives/ Learning Outcomes	Knowledge: The students will learn about the current state of the art in machine learning on graphs. After completing this course, students will have an in-depth overview of machine learning algorithms used for graph data. On the theoretical side, they will have a thorough understanding of neural and non-neural methods for machine learning on graphs and know about their limitations in terms of expressivity and generalization. On the practical side, they will know about typical use cases of machine learning with graphs. Skills: After completing this course, students will be able to prove limitations of machine learning methods for graphs. Further, they will be able to implement state-of-the-art algorithms. Competences: After completing this course, students will be able to • assess the limitations of state-of-the-art machine learning algorithms for graphs, • implement state-of-the-art methods, and • apply theoretical insights of machine learning algorithms for graphs to real-world problems
(Study-Specific) Prerequisites	-
(recommended) Requirements	Solid Knowledge of Linear Algebra und basic knowledge of graph theory.
References	-
Language	English
Examination Terms	Written or oral exam (100%). ;Students must pass written homework to be admitted to the module examination.
Miscellaneous	-

Module coordinator	-
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	-
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Machine Learning with Graphs: Foundations and Applications (122799601)	6th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture/Exercise Machine Learning with Graphs: Foundations and Applications	6th semester	no semester recommended	-	4

Module titel	Mathematical Logic II (Compulsory elective subject)
Identifier	1112957
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	irregularly
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor/Master
Content	set theory and foundations of mathematics, ordinal and cardinal numbers, axiom of choice, Gödel's incompleteness theorems, introduction to model theory, fixed-point logics
Learning Objectives/ Learning Outcomes	Students shall gain insight into the foundational problems of mathematics (and computer science) and understand the benefits and limitations of the axiomatic system ZFC as the set-theoretic foundation of mathematics. The methods and tools from the course "Mathematical Logic" shall be built upon and extended. In particular, students shall be introduced to working with ordinal numbers, transfinite induction and basic model-theoretic methods. In addition to the formal systems covered in "Mathematical Logic", the focus lies in particular on fixed-point logics (the modal μ-calculus and LFP). The goal is to understand the expressive power of those formalisms and to learn how to express mathematical concepts in fixed-points logics.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Teilnahmebedingungen: Kenntnisse des Moduls Mathematische Logik I
References	-
Language	German/English
Examination Terms	Zulassungsvoraussetzung: Lösen von Übungsaufgaben Prüfungsleistung: Bestehen einer Klausur oder einer mündlichen Prüfung; Prüfungsdauer und -art werden am Anfang des Semesters bekannt gegeben
Miscellaneous	-
Module coordinator	N.N.
ECTS Credits	6
Contact time (WSH)	6
Examination duration (min)	-
Total hours (h)	180,0
Contact hours (h)	90,0
Self-study hours (h)	90,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Mathematical Logic II (111295702)	5th semester	no semester recommended	0	2
Exam Mathematical Logic II (111295701)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Mathematical Logic II	5th semester	no semester recommended	-	4

Module titel	Model Checking (Compulsory elective subject)
Identifier	1212328
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Summer semester 2018
Valid until	-
Module level	Bachelor/Master
Content	Main topics: • Transition systems • Concurrent and channel systems • Property classes: safety, liveness, invariants, and fairness • Linear Temporal Logic (LTL) • Computation Tree Logic (CTL) • Model Checking algorithms for LTL and (fair) CTL • Abstraction: (Bi)simulation
Learning Objectives/ Learning Outcomes	Acquisition of the following knowledge, skills and competences: • Modeling of (concurrent) programs • Knowledge of property classes • Understanding the construction and functioning of model-checking algorithms for LTL and CTL • Understanding of elementary abstraction mechanisms • Capability of employing Model Checkers (Spin)
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Knowledge of fundamental automata models and regular languages. Knowledge of propositional logic. Knowledge of basic data structures such as stacks, trees, and graphs and related algorithms. Basic knowledge of complexity theory.
References	Folien zur Vorlesung sowie folgende Lehrbücher: • C. Baier, J.-P. Katoen: Principles of Model Checking, MIT Press, 2008. • M. Huth and M.D. Ryan: Logic in Computer Science, Modelling and Reasoning about Systems, Cambridge Univ. Press, 2004. • E.M. Clarke, O. Grumberg, D. Peled: Model Checking, MIT Press, 1999.
Language	English
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the examination.
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Modulangebotsverantwortlicher InformatikModellierungsteamverantwortlicher: Dr. rer. nat. Katja PetzoldtModulverantworlicher: Universitätsprofessor i.R. Dr. rer. nat. Dr. h. c. Dr. h. c. Wolfgang ThomasUniversitätsprofessor Dr. ir. Dr. h. c. (AAU) Joost-Pieter Katoen
ECTS Credits	6
Contact time (WSH)	5

Model Checking (1212328)

Examination duration (min)	0
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Model Checking (121232802)	5th semester	no semester recommended	0	2
Exam Model Checking (121232801)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Model Checking	5th semester	no semester recommended	-	3

Module titel	Modeling and analysis of hybrid systems (Compulsory elective subject)
Identifier	1212339
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Summer semester 2018
Valid until	-
Module level	Bachelor/Master
Content	Hybrid systems are systems with mixed discrete and continuous behaviour. Typical examples are physical systems which continuously evolve over time and which are controlled by some discrete controller, e.g., a chip or a computer. The behaviour of hybrid systems is often safety-critical. For example, in case of an accident an airbag can save the life of the car driver, but only if the airbag reacts in time. To assure the correct functioning of such safety-critical hybrid systems, their automatic synthesis and analysis is of high importance. In the lecture we first introduce hybrid automata to model hybrid systems and logics to specify safety and lifeness properties of the models. We introduce different classes of hybrid automata with increasing expressive power. For each class we discuss whether the reachability problem is decidable, and develop algorithms for their analysis. Finally we discuss methods for abstraction and for the over-appoximative representation of state sets and show how they can be used for reachability analysis. Contents: • Discrete, continuous and hybrid systems, examples • Modeling formalism: hybrid automata • Some important features: time determinism, time divergence, Zeno-behaviour, stability etc. • Interesting classes of hybrid automata: timed automata, rectangular automata, linear hybrid automata, non-linear hybrid automata • Analysis: model checking, abstraction, approximation
Learning Objectives/ Learning Outcomes	Knowledge: In this lecture the students will learn modeling formalisms for discrete, continuous and hybrid systems, formalisms to specify relevant properties of those models, and gain knowledge in the areas of verification, abstraction and approximation algorithms to prove or disprove the validity of those properties. They will get known to different classes of hybrid automata and learn the advantages and disadvantages of their expressive power including decidability results. Skills: The students collect experiences in the application of the above formalisms to build models of real-world systems at different abstraction levels and to formalize and prove their correct functioning. For complex or undecidable problems they will be able to apply safe abstraction and approximation techniques. Interactive learning methods help to increase the interest in theoretical computer science and to improve communication skills (e.g., the verbal formalization of scientific problems). Competences: The students will know when and how they can apply formal techniques during the development of complex systems. They will train logical and analytical thinking, especially for the development of complex safety-critical systems involving physical components. They will recognize the importance of the application of formal methods in these procedures.
(Study-Specific) Prerequisites	None.

– Electives
– Elective Theoretical Computer Science
+ Modeling and analysis of hybrid systems (1212339)

(recommended) Requirements	None.
References	To be announced in the lecture
Language	English
Examination Terms	Written exam or oral examination (100 %). Students must pass written homework to be admitted to the module examination.
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Modulangebotsverantwortlicher Informatik Modellierungsteamverantwortlicher: Dr. rer. nat. Katja Petzoldt Modulverantworlicher: Universitätsprofessorin Dr. Erika Abraham
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	0
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Modeling and analysis of hybrid systems (121233902)	6th semester	no semester recommended	0	1
Exam Modeling and analysis of hybrid systems (121233901)	6th semester	no semester recommended	6	0

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Modeling and analysis of hybrid systems	6th semester	no semester recommended	-	3

Module titel	Linear Optimization and Network Algorithms (Compulsory elective subject)
Identifier	1126871
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2024
Valid until	-
Module level	Bachelor
Content	Kürzeste Wege, Maximale Flüsse, Bipartites Matching, Flüsse mit minimalen Kosten, Grundlagen der konvexen Optimierung, Lineare Optimierung, Grundlagen der Komplexitätstheorie, Dynamische Programmierung
Learning Objectives/ Learning Outcomes	Die Studierenden sollen Kenntnis und Verständnis der grundlegenden Begriffe, Modelle und Methoden aus der Linearen Optimierung und der Netzwerkoptimierung erwerben. Sie sollen lernen, Optimierungsprobleme aus der Praxis als lineare Optimierungsprobleme oder als Netzwerkflussprobleme zu formulieren, Algorithmen aus Bereichen der Linearen Programmierung und Netzwerkflusstheorie zu verstehen, und zu analysieren, sowie Methoden zur Bestimmung der Komplexität anzuwenden.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Kenntnisse des Moduls Lineare Algebra I (oder äquivalent), Grundkenntnisse in Algorithmik
References	Skript zur Vorlesung, Unterrichtsmaterialien
Language	German/English
Examination Terms	Zulassungsvoraussetzung: Lösen von Übungsaufgaben, Prüfungsleistung: Bestehen einer Klausur oder einer mündlichen Prüfung (benotet); Prüfungsdauer und - art werden zu Beginn der Lehrveranstaltung bekannt gegeben.
Miscellaneous	-
Module coordinator	Univ. Prof. Dr. Ir. Arie M.C.A. Koster, Univ. Prof. Dr. rer. nat. Britta Peis, Univ. Prof. Dr. rer. nat. Christina Büsing
ECTS Credits	9
Contact time (WSH)	6
Examination duration (min)	-
Total hours (h)	270,0
Contact hours (h)	90,0
Self-study hours (h)	180,0

RWTHAACHEN UNIVERSITY

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Linear Optimization and Network Algorithms (112687101)	3rd semester	no semester recommended	9	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Linear Optimization and Network Algorithms	3rd semester	no semester recommended	-	4
Tutorial Linear Optimization and Network Algorithms	3rd semester	no semester recommended	-	2

Module titel	Inorganic Chemistry (Compulsory elective subject)
Identifier	1515454
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2013
Valid until	-
Module level	Bachelor
Content	a)/b) Elemente, Periodensystem, Valenz, kovalente Bindung, Molekülbau, kovalente Festkörper, Kristallbau, Metalle, Salze, chemische Reaktionen, Säure-Base-Reaktionen, Lewis-Broensted-Säuren/-Basen, pH-Wert, Komplexe. c)/d) Kinetische Gastheorie: Mittlere freie Weglänge, Stosszahlen; Formalkinetik: Reaktionsgeschwindigkeit; Reaktionen 1. und 2. Ordnung, Rück-, Folge-, Parallelreaktionen, Enzymkinetik; Arrheniusgleichung, Experimentelle Methoden; Transportprozesse: Diffusion, Viskosität, Wärmeleitfähigkeit e)/f) Anorganisch-chemischer Teil: Gravimetrie, Elektrogravimetrie, Neutralisationstitration, Potentiometrie, Fällungstitration, Komplextitration. Rücktitration, Redoxtitration, Löslichkeitsprodukt, Ionenaustauscher zur Trennung, Röntgenfluoreszenzspektroskopie, Abwasseraufbereitung, Atomabsorptionsspektroskopie, Bleiakkumulator Physikalisch-chemischer Teil: Ideale Gase: Bestimmung der molaren Masse nach Dumas, Formalkinetik: Bestimmung von partiellen Reaktionsordnungen, Reaktionen 1. und 2. Ordnung: Landoltreaktion, Esterverseifung, Mangantrioxalatzerfall, Massenwirkungsgesetz: Bestimmung von Gleichgewichtskonstanten, Temperaturabhängigkeit von Geschwindigkeitskonstanten, Messmethoden
Learning Objectives/ Learning Outcomes	Die Studierenden erlangen Grundkenntnisse zu chemischem Verhalten und chemischen Reaktionen sowie zur Analytik von Feststoffen und Lösungen. Außerdem erwerben sie Wissen über den Aufbau der Materie, in Kinetik und kinetischer Gastheorie sowie über die Evaluation von Messdaten. Im Praktikum erlangen die Studierenden dann die Fähigkeit, wichtigste Phänomene durch den Verlauf von Experimenten zu beschreiben, zu planen und mittels üblicher Laborgeräte durchzuführen. Es können Aussagen über die Genauigkeit der Versuche (Signifikanz und Fehlerrechnung) gemacht werden. Es werden Kenntnisse im Umgang mit Gefahrstoffen erworben.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	none
References	a)/b) C. E. Mortimer, U. Müller: Chemie; E. Riedel: Anorganische Chemie; Jander, Jahr: Maßanalyse; Lux, Fichtner: Quantitative Analyse; E. Gerdes, Qualitative Analyse c)/d) P. W. Atkins, Physikalische Chemie; G. Wedler, Physikalische Chemie; R.J. Silbey, R.A. Alberty: Physical Chemistry
Language	German
Examination Terms	Teilnahmevoraussetzung für die Klausur: Erfolgreiche Teilnahme an den Übungen. Es wird eine Klausur (120-150 Min.) für Mathematiker gestellt, die sich nur auf Vorlesung und Übung bezieht.
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Modulangebotsverantwortlicher ChemieModellierungsteamverantwortlicher: Dr. rer. nat. Katja PetzoldtModulverantworlicher:

– Applied Courses
– Chemistry
+ Inorganic Chemistry (1515454)

	Unbekannt
ECTS Credits	8
Contact time (WSH)	6
Examination duration (min)	0
Total hours (h)	240,0
Contact hours (h)	90,0
Self-study hours (h)	150,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Inorganic Chemistry (151545401)	3rd semester	no semester recommended	8	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Inorganic Chemistry	3rd semester	no semester recommended	-	2
Lecture Inorganic Chemistry	3rd semester	no semester recommended	-	4

Module titel	Organic Chemistry (Compulsory elective subject)
Identifier	1515455
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Summer semester 2014
Valid until	-
Module level	Bachelor
Content	a) Bindung, Isomerie, Alkane, Cycloalkane, Alkene, Alkine, Aromatische Verbindungen, Stereoisomerie, Organische Halogenverbindungen (Substitution und Eliminierung), Alkohole, Phenole, Thiole, Ether, Epoxide, Aldehyde, Ketone, Carbonsäuren und Derivate, Amine, Heterocyclische Verbindungen, Lipide, Kohlenhydrate, Aminosäuren, Peptide, Proteine, Nucleotide, Nucleinsäuren b)/c) Struktur der Materie: Grundlagen der Quantenmechanik, Einfache Modelle: Teilchen im Kasten, Harmonischer und anharmonischer Oszillator, Planarer Rotator, Freier Rotator; Grundlagen der Spektroskopie: Auswahlregeln, Rotationsspektren linearer Moleküle, Schwingungsspektren zweiatomiger Moleküle, Normalschwingungen von Wasser und CO2, UV/VIS-Spektren d) Qualitative anorganische Analyse an Reinsubstanzen und an Substanzgemischen, Trennung von Gemischen (Fällungsreaktionen, Komplexierungen, Redoxchemie), Aufschlußreaktionen für die Chemie in wässriger Lösung und in der Schmelze, Spektroskopie, chromatographische Trennung von Metallkomplexen und quantitative Analyse von Konstituenten, Ionenchromatographie, Trinkwasseranalytik; Trennmethoden der Organischen Chemie (Destillation, Extraktion, Kristallisation, Sublimation), Derivatisierungen, einfache Grundreaktionen der Organischen Chemie (Veresterung, Grignard Reaktion, Diels Alder Reaktion, Photochemie, Elektrochemische Reaktionen), Isolierung einfacher Naturstoffe
Learning Objectives/ Learning Outcomes	Die Studierenden sollen die Chemie des Kohlenstoffs und seiner Derivate kennen lernen, wobei ein großer Wert auf die Vermittlung des Stoffs strukturiert nach "funktionellen Gruppen" gelegt wird. Dies führt zu grundlegenden Stoff- und Reaktivitätskenntnissen in der Organischen Chemie und legt das Fundament für ein mechanistisches Verständnis. Die zur Umsetzung des theoretischen Wissens benötigten grundlegenden Arbeitstechniken werden in dem praktischen Teil vermittelt. Die Studierenden werden durch die Veranstaltungen befähigt funktionelle Gruppen und deren Reaktivitätsmuster zu erkennen. Einfache Umwandlungen funktioneller Gruppen ineinander können geplant und experimentell umgesetzt werden. Die benötigten handwerklichen Techniken und präparativen Grundlagen werden in Theorie und Experiment erarbeitet. Im physikalisch-chemischen Teil sollen die theoretischen Grundlagen zum Verständnis moderner spektroskopischer Strukturaufklärungsmethoden erlernt werden. Diese versetzen die Studierenden in die Lage, diese Methoden sachkundig auf beliebige chemische Verbindungen und Materialien anzuwenden und die erhaltenen Spektren zu interpretieren. Somit erlernen die Studierenden unter anderem wie man strukturelle Informationen über unbekannte Reaktions- und Zwischenprodukte erhält, um chemische Umsetzungen zu kontrollieren und zu verfolgen. Im anorganisch-chemischen Teil müssen die Studierenden sich mit den verschiedenen Substanzklassen der Anorganischen Chemie auseinandersetzen und mehrere qualitative Analysen von Substanzgemischen durchführen. Die Studierenden sollten die wichtigsten Phänomene und den Verlauf einfacher Experimente schriftlich und mündlich beschreiben können.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	none
References	a) K. P. C. Vollhardt, N. E. Schore, Organische Chemie, H. Hart, L. E. Craine, D. J. Hart, Organische Chemie, H. Beyer, W. Walter, Lehrbuch der Organischen Chemie; Organikum b)/c) P. W. Atkins, Physikalische Chemiea) d) Jander, Jahr: Maßanalyse; Lux, Fichtner: Quantitative

	Analyse; E. Gerdes, Qualitative Analyse; Jander, Blasius: Lehrbuch der analytischen und präparativen anorganischen Chemie
Language	German
Examination Terms	Die Klausur (Teilklausur Organische Chemie) beruht nur auf der Vorlesung, die Prüfungsdauer wird am Anfang des Semesters bekannt gegeben
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Modulangebotsverantwortlicher ChemieModellierungsteamverantwortlicher: Dr. rer. nat. Katja PetzoldtModulverantworlicher: Unbekannt
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	0
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Organic Chemistry (151545501)	4th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Organic Chemistry	4th semester	no semester recommended	-	4

Module titel	Computational Chemistry (Compulsory elective subject)
Identifier	1510097
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Summer semester 2009
Valid until	-
Module level	Bachelor/Master
Content	Kraftfeldrechnungen, Kraftfeldparameter, Hartree-Fock-Methode, Potentialflächen, Slater-Determinante, Basissätze, LCAO-MO-Ansatz, Semiempirik, Blochsches Theorem, eindimensionale Systeme, Zustandsdichte, Elektronenkorrelation, Dichtefunktionaltheorie
Learning Objectives/ Learning Outcomes	Die Modellierung molekularer und ausgedehnter Systeme kann am Computer unter Anwendung gängiger Molecular Modelling-Programme durchgeführt werden. Die Studierenden können die Relevanz unterschiedlicher Programme für spezielle Probleme abschätzen und auf experimentelle Systeme anwenden.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	none
References	A. Hinchcliffe: Molecular Modelling for Beginners, Wiley 2003, J. Reinhold: Quantentheorie der Moleküle, Teubner 2004, R. Dronskowski: Computational Chemistry of Solid State Materials, Wiley-VCH 2005.
Language	German
Examination Terms	In dem Modul Computational Chemistry (CCHEM) ist die folgende Leistung zu erbringen: - Klausur oder mündliche Prüfung Computational Chemistry zu allen Veranstaltungen Die Gesamtnote des Moduls CCHEM entspricht der Note der Klausur.
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Modulangebotsverantwortlicher Chemie Modulverantworlicher: Universitätsprofessor Dr. rer. nat. Richard Dronskowski
ECTS Credits	4
Contact time (WSH)	3
Examination duration (min)	0
Total hours (h)	120,0
Contact hours (h)	45,0
Self-study hours (h)	75,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Computational Chemistry Exam (151009701)	6th semester	no semester recommended	4	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Computational Chemistry Lecture	6th semester	no semester recommended	-	2
Computational Chemistry Exercise	6th semester	no semester recommended	-	1

Module titel	Theory of Chemical Bonds (Compulsory elective subject)
Identifier	1515984
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Summer semester 2014
Valid until	-
Module level	Bachelor
Content	Operatoren und ihre Eigenschaften, Eigenfunktionen und Eigenwerte, hermitische Operatoren, Impuls, Unschärferelation, Bahndrehimpuls, Hamiltonfunktion und Hamiltonoperator, Wasserstoffatom.
Learning Objectives/ Learning Outcomes	Die Studierenden können die Grundlagen der Quantenchemie erfassen. Sie haben damit ein Wissen erworben, das ihnen erlaubt, Disziplinen der Computerchemie in ihren Grundlagen zu verstehen.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	none
References	-
Language	German
Examination Terms	Die Benotung ergibt sich zu 100% aus der abschließenden Prüfung zum Modul, die in schriftlicher oder mündlicher Form erfolgt.
Miscellaneous	-
Module coordinator	Modulverantworlicher: Dr. rer. nat. Gerhard Raabe
ECTS Credits	4
Contact time (WSH)	3
Examination duration (min)	0
Total hours (h)	120,0
Contact hours (h)	45,0
Self-study hours (h)	75,0

– Applied Courses
– Chemistry
+ Theory of Chemical Bonds (1515984)

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Theory of Chemical Bonds (151598401)	5th semester	no semester recommended	4	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Theory of Chemical Bonds	5th semester	no semester recommended	-	2
Exercise Theory of Chemical Bonds	5th semester	no semester recommended	-	1

Module titel	Bookkeeping and Managerial Accounting (Compulsory elective subject)
Identifier	8014709
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2023
Valid until	-
Module level	Bachelor/Master
Content	Teil "Buchführung": • Zwecke und Zielgrößen der Finanzberichte von Unternehmen, • System der doppelten Buchführung, • Behandlung von relevanten Ereignissen während des Abrechnungszeitraums, • Behandlung von relevanten Ereignissen am Ende des Abrechnungszeitraums • Abschlussarbeiten Teil "internes Rechnungswesen": • Einführende Fallstudie • Problematik von Erlös- und Kostenrechnungen • Kostenartenrechnungen, • Kostenstellenrechnungen, • Kostenträgerrechnungen, • Anwendung von Erlös- und Kostenträgerrechnungen in verschiedenen Entscheidungssituationen, • Planungsrechnungen und Abweichungsermittlung
Learning Objectives/ Learning Outcomes	Nach erfolgreichem Absolvieren der Veranstaltung sollen Studierende die Grundlagen von Buchführung und internem Rechnungswesen verstanden haben und anwenden können. Im einzelnen sollen Studierende: Wissen/ Verstehen: a) Buchführungssystem und Buchführungsprozess verstanden haben, b) die grundlegenden Finanzberichte von Unternehmen kennen und wissen, wie diese aus Daten der Buchführung herzuleiten sind, c) wissen wie diese Daten im Rahmen eines internen Rechnungswesens in unternehmerische Entscheidungen einbezogen werden können. Fähigkeiten: a) Buchführung betreiben können und Methoden bzw. Verfahren des internen Rechnungswesens beherrschen, b) in die Lage versetzt werden, mittels des internen Rechnungswesens unternehmerische Entscheidungen zu fundieren. Durch die Veranstaltung sollen die Studierenden folgende Kompetenzen erwerben:

	- Wissen und Fähigkeit zur Anwendung wirtschaftlicher Methoden und Theorien - Kritisches Hinterfragen von wirtschaftlichen Problemstellungen - Quantitative Methoden und angewandte Lösungsverfahren.
(Study-Specific) Prerequisites	-
(recommended) Requirements	None
References	Möller, H.P., Hüfner, B., Ketteniß, H.: Buchführung und Finanzberichte, 5., Auflage, Wiesbaden (SpringerGabler) 2018. Friedl, G., Hofmann, C., Pedell, B.: Kostenrechnung ? Eine entscheidungsorientierte Einführung, 3. Auflage München (Vahlen) 2017. Möller, H.-P., Hüfner, B., Ketteniß, H.: Internes Rechnungswesen, 2. Auflage, Heidelberg et al. (Springer) 2010.
Language	German
Examination Terms	1. Modulbaustein als Prüfungsvoraussetzung (verpflichtend): Voraussetzung für die Zulassung zur Prüfung ist das Bestehen von Hausaufgaben, 2. Klausur (100%, benotet, 70min.) 3. Modulbaustein (freiwillig): Möglichkeit zur Notenverbesserung der Note der regulären Prüfung um 0,3 bzw. 0,4 Notenpunkte durch erfolgreiches Absolvieren von online-Hausaufgaben
Miscellaneous	-
Module coordinator	Dr. rer. pol. Claudia Nadler
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	70
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Bookkeeping and Managerial Accounting (Exam) (801470901)	3rd semester	no semester recommended	6	0
Bookkeeping and Managerial Accounting (Module Component) (801470902)	3rd semester	no semester recommended	0	0

▲Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Bookkeeping and Managerial Accounting (Lecture)	3rd semester	no semester recommended	-	2
Bookkeeping and Managerial Accounting (Exercise)	3rd semester	no semester recommended	-	2

Module titel	Decision Theory (Compulsory elective subject)
Identifier	8013176
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2005
Valid until	-
Module level	Bachelor
Content	In a descriptive part of the course, typical errors in decision behavior and possible biases in subjective assessments are discussed first. As a prescriptive answer to these rationality weaknesses, a decision process is presented with which a reflected decision with high decision quality can be achieved. This decision-making process will also be practiced by the participants by working on their own problem with the online training tool Entscheidungsnavi.
Learning Objectives/ Learning Outcomes	Upon successful completion, students should (1) know the typical decision and estimation errors, (2) be able to apply methods and tools for rational decision making and (3) be able to make reflective decisions using their head (analytics) and gut (intuition).
(Study-Specific) Prerequisites	None.
(recommended) Requirements	None
References	Von Nitzsch, R. (2006): Entscheidungslehre, Aachen 2006. Bamberg, G./Coenenberg, A.G. (2000): Betriebswirtschaftliche Entscheidungslehre, 10. Aufl., München 2000. Eisenführ, F./Weber, M. (2002): Rationales Entscheiden, 4.Aufl., Berlin 2002.
Language	German
Examination Terms	Klausur (100%, benotet, 60min.) Modulbaustein: Bei erfolgreicher Absolvierung einer freiwilligen Zusatzleistung (eigenständige Analyse eines Entscheidungsproblems mit dem Entscheidungsnavi) wird die Klausurnote – sofern diese 4,0 oder besser beträgt – um 0,3 bzw. 0,4 Notenpunkte verbessert.
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. rer. pol. Rüdiger von Nitzsch
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	60
Total hours (h)	180,0
Contact hours (h)	60,0

Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Decision Theory (801317601)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Decision Theory	5th semester	no semester recommended	-	2
Tutorial Decision Theory	5th semester	no semester recommended	-	2

Module titel	Operations Research (Compulsory elective subject)
Identifier	8015049
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Winter semester 2021
Valid until	-
Module level	Bachelor
Content	In der Lehrveranstaltung werden quantitative Methoden der Wirtschaftswissenschaften vorgestellt. Insbesondere werden Modelle, Methoden und Algorithmen behandelt, die eine besonders hohe Bedeutung für die Wirtschaftswissenschaften und für Anwendungen in der Praxis besitzen. Im Einzelnen werden Lineare Optimierung und eine Einführung in die Diskrete und Kombinatorische Optimierung behandelt.
Learning Objectives/ Learning Outcomes	Knowledge Nach erfolgreichem Absolvieren der Lehrveranstaltung werden die Studierenden - die wichtigsten Grundlagen, Methoden und Algorithmen der Linearen Optimierung kennen, - Probleme und Methoden zur Behandlung gemischt-ganzzahliger Optimierungsprobleme kennen Skills - in der Lage sein, spezielle lineare bzw. gemischt-ganzzahlige Optimierungsprobleme mit einer Modellierungssprache abzubilden und zu lösen Competences - in der Lage sein, Probleme aus der Produktionsplanung und Logistik (insbesondere Transport) als Lineare Optimierungsprobleme zu modellieren
(Study-Specific) Prerequisites	-
(recommended) Requirements	Keine über die generellen Anforderungen des Bachelor-Studienganges hinausgehenden Voraussetzungen
References	H.-J. Zimmermann, Operations Research Methoden und Modelle, Vieweg, 2005 K. Neumann, M. Morlock, Operations Research, 2. Auflage, Hanser, 2002
Language	German
Examination Terms	Klausur (100%, benotet) Zulassungsvoraussetzung zur Prüfungsleistung: Regelmäßiges Bearbeiten und Erwerb von Punkten für das korrekte Lösen von Übungsaufgaben
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. rer. nat. habil. Marco Lübbecke
ECTS Credits	5
Contact time (WSH)	4
Examination duration (min)	90

– Applied Courses
– Business Administration
+ Operations Research (8015049)

Total hours (h)	150,0
Contact hours (h)	60,0
Self-study hours (h)	90,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Operations Research (801504901)	4th semester	no semester recommended	5	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Vorlesung Quantitative Methoden (Operations Research)	4th semester	no semester recommended	-	2
Übung Quantitative Methoden (Operations Research)	4th semester	no semester recommended	-	2

Module titel	Principles of Management (Compulsory elective subject)
Identifier	8024098
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2021
Valid until	-
Module level	Bachelor
Content	Dieser Kurs gibt einen Überblick über grundlegende Modelle, Theorien und Prinzipien der Betriebswirtschaftslehre. Der Kurs beginnt mit der Frage, warum es Unternehmen gibt und was der Kern unternehmerischer Wertschöpfung ist. Anschließend wird analysiert, welche Alternativen und Theorien es zur Organisation von Unternehmen gibt. Ein Schwerpunkt auf die neue Institutionenökonomie erlaubt dabei einen Einblick in einen der Ansätze, der das moderne Management entscheidend geprägt hat. In den letzten beiden Teilen werden Prinzipien der operativen Planung sowie Sustainability behandelt. Anhand ausgewählter Konzepte lernen die Teilnehmenden die wichtigsten Ansätze einer nachhaltigen Unternehmensführung kennen. ; Dieser Kurs besteht aus insgesamt sechs Modulen und einem Exkurs: Modul 1: Grundzüge und Funktionen der Unternehmung Modul 2: Organisationstheorien: Der Weg zum Taylorismus und dessen Überwindung Modul 3: Gestaltung der Organisationsstruktur Modul 4: Neue Institutionenökonomik Modul 5: Operative Planung Modul 6: Sustainability ; Exkurs: Economies of Scale and Scope
Learning Objectives/ Learning Outcomes	- Die Teilnehmenden kennen grundlegende Denkweisen der Betriebswirtschaftslehre. - Die Teilnehmenden können wesentliche Fachbegriffe ebenso wie grundlegende Konzepte auf aktuelle Fragestellungen übertragen. - Die Teilnehmenden können einen Bezug zwischen den theoretisch vermittelten Kursinhalten und der unternehmerischen Praxis herzustellen. - Die Teilnehmenden verfügen über eine kritisch-reflektierte Herangehensweise an wirtschaftliche Fragestellungen. - Die Teilnehmenden verfügen über einen Rahmen für weitere vertiefende Vorlesungen im Bereich BWL.
(Study-Specific) Prerequisites	-
(recommended) Requirements	None
References	-
Language	German

Principles of Management (8024098)

Examination Terms	Klausur (100%, benotet) und Modulbaustein (im Falle des Bestehens der Klausur, kann durch erfolgreiche Teilnahme an semesterbegleitenden e-learning Hausaufgaben eine Verbesserung der Klausurnote um 0.3 bzw. 0.4 erreicht werden, wenn über 70% der möglichen Punkte erreicht wurden. Es kann eine Verbesserung um 0.6 bzw. 0.7 erreicht werden, wenn über 95% der möglichen Punkte erreicht wurden). Die Klausur und Wiederholungsklausur werden zu Beginn bzw. Ende des auf das jeweilige Wintersemester folgenden Prüfungszeitraums angeboten.
Miscellaneous	-
Module coordinator	Univ.-Prof. Dr.rer.pol. Frank Thomas Piller
ECTS Credits	5
Contact time (WSH)	3
Examination duration (min)	60
Total hours (h)	150,0
Contact hours (h)	45,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Principles of Management (Exam (802409801)	5th semester	no semester recommended	5	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Principles of Management (Lecture)	5th semester	no semester recommended	-	2
Principles of Management (Tutorial)	5th semester	no semester recommended	-	1

Module titel	Basic Module Philosophical Propaedeutics (Compulsory elective subject)
Identifier	7014543
Version	V2
Duration (Semester)	two semesters
Cycle (Semester)	winter semester
Valid from	Winter semester 2019
Valid until	-
Module level	Bachelor
Content	Die Studierenden werden aus einer überwiegend systematischen Perspektive, aber unter Einbeziehung wichtiger historischer Positionen, mit philosophischen Fragestellungen, philosophischen Methoden und wichtigen Grundbegriffen zentraler Disziplinen der theoretischen Philosophie vertraut gemacht. Behandelt werden insbesondere die Erkenntnistheorie, die Metaphysik und Ontologie, die Philosophie des Geistes, die Sprachphilosophie sowie die Metaethik und Ästhetik.
Learning Objectives/ Learning Outcomes	Grundverständnis für philosophische Fragestellungen und philosophisches Argumentieren. Vertrautheit mit wichtigen Grundbegriffen, Positionen und Argumenten aus zentralen Disziplinen der theoretischen Philosophie.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	None
References	-
Language	German
Examination Terms	Die Modulnote ergibt sich aus zwei Teilprüfungen: Je eine Klausur (je 45 Minuten) oder je eine mündliche Prüfung (20 Minuten) zu den Vorlesungen. Die Erbringungsform, ob Klausur oder mündliche Prüfung, wird in der 2. Semesterwoche bekanntgegeben.
Miscellaneous	-
Module coordinator	• Modulangebotsorganisation: LeMa-Team Philosophische Fakultät, modulangebotsorganisation@fb7.rwth-aachen.de • Modulverantwortung: Univ.-Prof. Dr. phil. Maria Elisabeth Reicher-Marek
ECTS Credits	10
Contact time (WSH)	4
Examination duration (min)	-
Total hours (h)	300,0
Contact hours (h)	60,0
Self-study hours (h)	240,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Written Examination/Oral Examination: Lecture Introduction to Philosophy II (701454302 2)	4th semester	no semester recommended	5	0
Written Examination/Oral Examination: Lecture Introduction to Philosophy I (701454301 2)	3rd semester	no semester recommended	5	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Vorlesung Einführung in die Philosophie I (2)	3rd semester	no semester recommended	-	2
Vorlesung Einführung in die Philosophie II	3rd semester	no semester recommended	-	2

Module titel	(Compulsory elective subject)
Identifier	7027836
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Summer semester 2022
Valid until	-
Module level	Bachelor
Content	Theorien der Bedeutung, Referenz und Kommunikation, Sprache und Denken.
Learning Objectives/ Learning Outcomes	Kenntnis und vertieftes Verständnis grundlegender sprachphilosophischer Fragestellungen und wichtiger historischer und gegenwärtiger Positionen. Fähigkeit, auch komplexere Argumente nachzuvollziehen und selbständig kritisch zu analysieren und zu bewerten. Fähigkeit zur selbständigen Lektüre einschlägiger Fachliteratur.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Grundverständnis für philosophische Fragestellungen und philosophisches Argumentieren. Vertrautheit mit wichtigen Grundbegriffen der Hauptdisziplinen der Theoretischen Philosophie. Praktische Kompetenz in Literaturrecherche, Argumentrekonstruktion und wissenschaftlichem Schreiben in der Philosophie. Fähigkeit, philosophische Texte unter Anleitung kritisch reflektierend und/oder exegetisch zu interpretieren.
References	-
Language	German/English
Examination Terms	Klausur oder mündliche Prüfung zur Vorlesung bzw. Hausarbeit oder schriftl. Hausaufgaben zum Seminar Sprachphilosophie. Die Modulnote ist die Note dieser Prüfung. Im Seminar besteht Anwesenheitspflicht, sofern es als reine Präsenzveranstaltung angeboten wird, da das Lernziel der Vertiefung, Erweiterung und Verfestigung philosophischer Schlüsselkompetenzen und Fähigkeiten ohne Anwesenheit nicht oder nur mit erheblichem Mehraufwand erreicht werden kann.
Miscellaneous	-
Module coordinator	• Modulangebotsorganisation: LeMa-Team Philosophische Fakultät, modulangebotsorganisation@fb7.rwth-aachen.de • Modulverantwortung: Prof. Dr. Maria Reicher-Marek
ECTS Credits	5
Contact time (WSH)	2
Examination duration (min)	-
Total hours (h)	150,0
Contact hours (h)	30,0

Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Klausur oder mündliche Prüfung zur Vorlesung bzw. Hausarbeit oder schriftl. Hausaufgaben zum Seminar Sprachphilosophie (702783601)	3rd semester	no semester recommended	5	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Vorlesung oder Seminar Sprachphilosophie	3rd semester	no semester recommended	-	2

Module titel	(Compulsory elective subject)
Identifier	7027837
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Summer semester 2022
Valid until	-
Module level	Bachelor
Content	Kategorien und Kategoriensysteme, Universalien, Existenz, Seinsweisen, Realismus versus Idealismus, Nominalismus versus Platonismus.
Learning Objectives/ Learning Outcomes	Kenntnis und vertieftes Verständnis grundlegender ontologischer Fragestellungen und wichtiger historischer und gegenwärtiger Positionen. Fähigkeit, auch komplexere Argumente nachzuvollziehen und selbständig kritisch zu analysieren und zu bewerten. Fähigkeit zur selbständigen Lektüre einschlägiger Fachliteratur.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Grundverständnis für philosophische Fragestellungen und philosophisches Argumentieren. Vertrautheit mit wichtigen Grundbegriffen der Hauptdisziplinen der Theoretischen Philosophie. Praktische Kompetenz in Literaturrecherche, Argumentrekonstruktion und wissenschaftlichem Schreiben in der Philosophie. Fähigkeit, philosophische Texte unter Anleitung kritisch reflektierend und/oder exegetisch zu interpretieren.
References	-
Language	German/English
Examination Terms	Klausur oder mündliche Prüfung zur Vorlesung bzw. Hausarbeit oder schriftl. Hausaufgaben zum Seminar Ontologie. Die Modulnote ist die Note dieser Prüfung. Im Seminar besteht Anwesenheitspflicht, sofern es als reine Präsenzveranstaltung angeboten wird, da das Lernziel der Vertiefung, Erweiterung und Verfestigung philosophischer Schlüsselkompetenzen und Fähigkeiten ohne Anwesenheit nicht oder nur mit erheblichem Mehraufwand erreicht werden kann.
Miscellaneous	-
Module coordinator	• Modulangebotsorganisation: LeMa-Team Philosophische Fakultät, modulangebotsorganisation@fb7.rwth-aachen.de • Modulverantwortung: Prof. Dr. Maria Reicher-Marek
ECTS Credits	5
Contact time (WSH)	4
Examination duration (min)	-
Total hours (h)	150,0
Contact hours (h)	60,0

Self-study hours (h)	90,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Klausur oder mündliche Prüfung zur Vorlesung bzw. Hausarbeit oder schriftl. Hausaufgaben zum Seminar Ontologie (702783701)	4th semester	no semester recommended	5	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Vorlesung oder Seminar Ontologie	4th semester	no semester recommended	-	2

Module titel	Basic Module Argumentation Theory and Logic (Compulsory elective subject)
Identifier	7019429
Version	V1
Duration (Semester)	two semesters
Cycle (Semester)	winter semester
Valid from	Winter semester 2018
Valid until	-
Module level	Bachelor
Content	In der Vorlesung werden sprachphilosophische und logische Grundlagen der Argumentationstheorie vermittelt. Thematisch werden Argumentationsstrukturen, Typen von Argumenten (deduktive und induktive Argumente, Plausibilitätsargumente), Argumentationsfehler, unfaire Argumentationsweisen und besondere Formen des Argumentierens wie (philosophische) Gedankenexperimente behandelt. Erörtert werden zudem die Frage des moralischen Argumentierens und des argumentativen Umgangs mit fundamentalistischen Positionen. Dabei werden die theoretischen Grundlagen anhand von Beispielen illustriert und der Umgang mit den unterschiedlichen Argumentationsverfahren exemplarisch eingeübt. Im Seminar "Lektürekurs Philosophie" werden ausgewählte philosophische Texte gelesen, interpretiert und diskutiert. Dabei sollen komplexe Argumentationen nachvollzogen, analysiert und kritisch evaluiert werden.
Learning Objectives/ Learning Outcomes	Allgemeines Grundverständnis von Argumentationsstrukturen und die Fähigkeit, unterschiedliche Argumentationstypen zu erkennen und bezüglich ihrer argumentativen Kraft einzuschätzen. Befähigung, Argumentationsfehler aufzudecken und unfaires Argumentieren zu entlarven. Basales Verständnis moralischer Argumente und des kritischen Umgangs mit fundamentalistischer Argumentation. Fähigkeit, philosophische Texte unter Anleitung exegetisch und/oder kritisch-reflektierend zu interpretieren. Befähigung, Argumente in Texten zu finden, zu strukturieren und kritisch zu überprüfen. Kompetenz, selbst Argumentationen mündlich oder schriftlich im Rahmen wissenschaftlicher Texte zu formulieren und zu diskutieren.
(Study-Specific) Prerequisites	-
(recommended) Requirements	-
References	-
Language	German
Examination Terms	Die Modulnote ergibt sich aus den Teilnoten aus der Klausur (45 Minuten) oder mündlichen Prüfung (20 Minuten) zur Vorlesung sowie aus der schriftlichen Hausarbeit (8 bis 10 Seiten) oder 3 kleineren Essays (von jeweils ca. 3 Seiten) (auch e-learning gestützt) zum Seminar "Lektürekurs Philosophie".
Miscellaneous	-
Module coordinator	• Modulangebotsorganisation: LeMa-Team Philosophische Fakultät, modulangebotsorganisation@fb7.rwth-aachen.de • Modulverantwortung: apl. Prof. Dr. Wulf Kellerwessel

Applied Courses
Philosophy
Basic Module Argumentation Theory and Logic (7019429)

ECTS Credits	9
Contact time (WSH)	4
Examination duration (min)	-
Total hours (h)	270,0
Contact hours (h)	60,0
Self-study hours (h)	210,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Homework Task(s)/Written Examination/Oral Examination: Lecture Argumentation Theory (701942901)	3rd semester	no semester recommended	5	0
Seminar/e-Seminar Reading Class Philosophy / Term Paper/Essays (701942903)	4th semester	no semester recommended	4	2

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Vorlesung Argumentationstheorie	3rd semester	no semester recommended	-	2

Module titel	Political Philosophy, Philosophy of Law and Social Philosophy (Compulsory elective subject)
Identifier	7023894
Version	V1
Duration (Semester)	two semesters
Cycle (Semester)	winter semester
Valid from	Winter semester 2020
Valid until	-
Module level	Bachelor
Content	Vorlesung Politische Philosophie Politische Philosophie im 20. Jahrhundert: Liberalismus und Kommunitarismus In der Vorlesung zur Politischen Philosophie werden Grundpositionen der modernen Politischen Philosophie einschließlich der Sozialphilosophie vorgestellt und kritisch diskutiert. Der Schwerpunkt liegt auf liberalen und libertaristischen Konzeptionen (z.B. von Popper, Hayek, Rawls, Dworkin, Nozick); eingegangen wird zudem auf den Kommunitarismus (z.B. Sandel, Walzer). Im Mittelpunkt steht jeweils die Frage, welchen Kriterien eine gerechte Gesellschaft genügen sollte. Vorlesung Menschenrechte In der Vorlesung zum Thema „Menschenrechte“ werden die Menschenrechte und philosophische Theorien der Menschenrechte vorgestellt, wobei der Fokus auf den unterschiedlichen Versuchen der Begründung dieser Rechte liegt. Eingegangen wird vor allem auf deontologische, liberale, kommunitaristische und utilitaristische Positionen.
Learning Objectives/ Learning Outcomes	Vorlesung Politische Philosophie: Verständnis grundlegender Beiträge zur Politischen Philosophie und Sozialphilosophie des 20. Jahrhunderts einschließlich ihrer Begründungen; Fähigkeit, die Positionen mitsamt ihren jeweiligen Voraussetzungen kritisch zu evaluieren; Kenntnis der Fachterminologie Vorlesung Menschenrechte: Wissen über die Menschenrechte und ihre Beziehungen zueinander; Kenntnisse grundlegender philosophischer Positionen in der Diskussion um die Menschenrechte und Begründungen der Menschenrechte; Verstehen der Voraussetzungen diverser menschenrechtlich relevanter Prämissen; Beherrschung der einschlägigen Terminologie
(Study-Specific) Prerequisites	-
(recommended) Requirements	Kenntnisse des Moduls „Ethics: Introduction and Application“
References	-
Language	German
Examination Terms	Die Modulnote ergibt sich aus der Klausur.
Miscellaneous	-
Module coordinator	• Modulangebotsorganisation: LeMa-Team Philosophische Fakultät, modulangebotsorganisation@fb7.rwth-aachen.de • Modulverantwortung: apl. Prof. Dr. Wulf Kellerwessel
ECTS Credits	10
Contact time (WSH)	4

Examination duration (min)	120
Total hours (h)	300,0
Contact hours (h)	60,0
Self-study hours (h)	240,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Written Examination Political Philosophy and Human Rights (702389401)	4th semester	no semester recommended	10	-

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Political Philosophy	3rd semester	no semester recommended	-	2
Lecture Human Rights	4th semester	no semester recommended	-	2

Module titel	Ethics: Introduction and Application (Compulsory elective subject)
Identifier	7023892
Version	V1
Duration (Semester)	two semesters
Cycle (Semester)	winter semester
Valid from	Winter semester 2020
Valid until	-
Module level	Bachelor
Content	Das Modul führt die Studierenden in die Grundlagen der Ethik ein und vertieft diese mit einem Seminar in der angewandten oder normativen Ethik. Nach einer Einführung in moralische Argumentation (z.B.: Wie argumentiert man in der Ethik? Welche Rolle haben moralische Intuitionen?) werden zentrale ethische Theorien vorgestellt und diskutiert. Im Anschluss daran stellt die Vorlesung Kernideen der Metaethik vor. Im letzten Teil der Vorlesung und im Seminar werden ausgewählte Bereiche der normativen und angewandten Ethik diskutiert, z.B. Fragen nach Verantwortung, zur Datenethik, Bioethik, oder Umweltethik.
Learning Objectives/ Learning Outcomes	Nach erfolgreichem Absolvieren sollen die Studierenden - Kernkonzepte, zentrale Theorien und Problemstellungen der Ethik nennen und erklären können - die Fähigkeit haben, moralische Argumente zu erkennen, zu beschreiben, und zu entwickeln, basierend auf philosophischen Texten und in eigener Argumentation - ein grundlegendes Verständnis für Problemstellungen und Herangehensweisen in der (angewandten) Ethik mit einem Schwerpunkt auf Anwendungen von Technologien haben - eigene Fragestellungen in der normativen und angewandten Ethik formulieren, ausgewogen diskutieren, und Positionen entwickeln können
(Study-Specific) Prerequisites	-
(recommended) Requirements	-
References	-
Language	German/English
Examination Terms	Die Modulnote (der benotete Leistungsnachweis des Moduls) ergibt sich gewichtet nach den CP aus den Noten in der Vorlesung (z.B. Klausur oder Hausarbeit/Essays) und im Seminar (Referat mit schriftlicher Ausarbeitung oder mündliche Prüfung). Die genaue Form wird zu Beginn der jeweiligen Veranstaltung bekannt gegeben.
Miscellaneous	-
Module coordinator	• Modulangebotsorganisation: LeMa-Team Philosophische Fakultät, modulangebotsorganisation@fb7.rwth-aachen.de • Modulverantwortung: Univ.-Prof. Dr. Saskia Nagel
ECTS Credits	10
Contact time (WSH)	4

Examination duration (min)	-
Total hours (h)	300,0
Contact hours (h)	60,0
Self-study hours (h)	240,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Graded Examination Lecture Introduction to Ethics (702389201)	3rd semester	no semester recommended	4	-
Graded Examination Seminar „Ethics: Applied and Normative” (702389202)	4th semester	no semester recommended	6	-

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture „Introduction to Ethics“	3rd semester	no semester recommended	-	2
Seminar „Ethics: Applied and Normative Questions”	4th semester	no semester recommended	-	2

Module titel	Introduction to epistomology (Compulsory elective subject)
Identifier	7014106
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2007
Valid until	-
Module level	Master
Content	Das Seminar ist eine einführende Lehrveranstaltung zur Erkenntnistheorie, deren Ziel es ist, die Teilnehmer mit den wichtigsten Grundbegriffen dieser zentralen philosophischen Disziplin vertraut zu machen. Die Fragen „Was ist Wissen?“ und „Wann sind wir berechtigt zu sagen, dass wir etwas wissen?“ sollen dabei sowohl von einer historischen als auch von einer systematischen Perspektive her beleuchtet werden. Die historische Betrachtung sieht den Erkenntnistheoretiker seit den Anfängen der Philosophie in einen Disput mit dem Skeptiker verstrickt. Letzterer geht davon aus, dass es kein Wissen gibt, wobei Skeptiker mit dieser Behauptung verschiedene Ziele verfolgen: Für Sokrates war der Skeptizismus ein Schritt auf dem Weg zum Wissen, pyrrhonische Skeptiker versuchten durch Einnahme einer skeptischen Position die Ataraxie zu erreichen, während die akademische Skepsis einfach den Standpunkt vertrat, dass es kein Wissen gibt. Diese Ziele werden bei vielen Philosophien offenkundig: René Descartes geht von einem methodischen Skeptizismus aus, um zu unbezweifelbaren Sätzen zu gelangen. David Hume weist auf das Induktionsproblem hin und vertritt damit einen theoretischen, partiellen Skeptizismus. In einer systematischen Betrachtung zeigen sich Fragen und Standpunkte, welche die Epistemologie immer wieder bzw. gegenwärtig beschäftigen: Quellen unserer Erkenntnis, Wissen und Wahrheit, synthetisches Wissen a ariori, Realismus und Idealismus, Quines naturalisierte Erkenntnistheorie.
Learning Objectives/ Learning Outcomes	Nach erfolgreicher Absolvierung der Lehrveranstaltung sollen die Teilnehmerinnen und Teilnehmer: - Grundbegriffe der Erkenntnistheorie nennen und erklären können. - Grundprobleme der Erkenntnistheorie nennen und erklären können. - verschiedene erkenntnistheoretische Positionen nennen, deren Thesen erklären und kritisch hinterfragen können. - sich eine fundierte Meinung bezüglich erkenntnistheoretischer Fragestellungen gebildet haben und diese ausdrücken können. - den eigenen Standpunkt bezüglich erkenntnistheoretischer Positionen darlegen, begründen und verteidigen können. - an einem fachlichen Diskurs bezüglich erkenntnistheoretischer Fragestellungen teilnehmen können.
(Study-Specific) Prerequisites	-
(recommended) Requirements	-
References	-
Language	German
Examination Terms	Graded Task(s)
Miscellaneous	-

- Applied Courses
- Philosophy
+ Introduction to epistomology (7014106)

Module coordinator	• Modulangebotsorganisation: LeMa-Team Philosophische Fakultät, modulangebotsorganisation@fb7.rwth-aachen.de • Modulverantung: Univ.-Prof. Dr. phil. Gabriele Gramelsberger
ECTS Credits	4
Contact time (WSH)	2
Examination duration (min)	-
Total hours (h)	120,0
Contact hours (h)	30,0
Self-study hours (h)	90,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Introduction to epistomology: Module examination (701410601)	3rd semester	no semester recommended	4	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Introduction to epistomology: Classes	3rd semester	no semester recommended	-	2

Module titel	Introduction to the philosophy of science (Compulsory elective subject)
Identifier	7014105
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Winter semester 2007
Valid until	-
Module level	-
Content	Gegenstand des Seminars werden die Grundbegriffe, die zentralen Fragestellungen sowie wichtige Positionen der Wissenschaftstheorie sein, die wir uns anhand klassischer Texte erarbeiten wollen. Dabei werden wir unter anderem eingehen auf Versuche der Abgrenzung der Wissenschaft von Pseudowissenschaften, auf die Duhem-Quine-These und die empirische Unterbestimmtheit von wissenschaftlichen Theorien, auf das Induktionsproblem sowie Poppers Falsifikationismus, auf Theorien der wissenschaftlichen Bestätigung und der wissenschaftlichen Erklärung, auf die Rolle von Beobachtung und Experiment, auf den Status von Naturgesetzen, auf die Theorie der wissenschaftlichen Revolutionen Kuhns, auf Feyerabends Argumentation wider den Methodenzwang sowie auf die Frage des wissenschaftlichen Realismus.
Learning Objectives/ Learning Outcomes	Grundkenntnisse im Bereich der Wissenschaftstheorie
(Study-Specific) Prerequisites	-
(recommended) Requirements	-
References	-
Language	German
Examination Terms	Written exam, oral exam or student's presentation
Miscellaneous	-
Module coordinator	• Modulangebotsorganisation: LeMa-Team Philosophische Fakultät, modulangebotsorganisation@fb7.rwth-aachen.de • Modulverantwortliche: Univ.-Prof Dr. phil. Gabriele Gramelsberger
ECTS Credits	3
Contact time (WSH)	2
Examination duration (min)	-
Total hours (h)	90,0
Contact hours (h)	30,0
Self-study hours (h)	60,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Introduction to the philosophy of science: Module examination (701410501)	4th semester	no semester recommended	3	0

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Introduction to the philosophy of science: Classes	4th semester	no semester recommended	-	2

Module titel	Fundamentals of Electrical Engineering 2 - Modeling and Analysis of Electrical Components and Circuits (Compulsory elective subject)
Identifier	6015555
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Summer semester 2008
Valid until	-
Module level	Bachelor
Content	Representation of alternating quantities: ac characteristics, real ac circuit analysis, vector representation, locus, complex ac circuit analysis, power concepts of ac quantities; Concentrated elements: basics and architecture of concentrated elements R, C, L, general system equations, switching states at concentrated elements, steady state harmonic analysis, steady state and transient events at RC and RL elements, resonant circuits, Bode diagram, transmission equations, steady state analysis, transformer Multiphase Systems: Electro-mechanical and power electronic generation of multi-phase systems, analysis of symmetrical three-phase networks, unbalanced load Nonlinear components and circuits: the real transformer, hysteresis and eddy current losses, nonlinear magnetic material properties, rectifier circuits, linear regulators, switch mode power supplies, batteries, dc motor basics (up to a simple equivalent circuit diagram), three-phase machines; Circuit simulations: Introduction to circuit simulation, use of simulation programmes to validate analytical solutions.
Learning Objectives/ Learning Outcomes	Nach erfolgreicher Teilnahme an der Modulveranstaltung sind die Studierenden in der Lage: • die Vorgänge in elektrischen Schaltungen bei transienten und sinusförmigen stationären Anregungen zu verstehen, - • die mathematischen Werkzeuge (Differentialgleichungen und komplexe Wechselstromrechnung) zur Berechnung von elektrischen Schaltungen anzuwenden und problemspezifisch die adäquaten Methoden auszuwählen, • ein strukturiertes Vorgehen bei der Lösung komplexer Probleme anzuwenden, • mathematische Modelle zur Beschreibung realer Probleme mit deren inhärenten Vereinfachungen zu verstehen und anzuwenden • Simulationsprogramme zur Veranschaulichung komplexer Fragestellungen einzusetzen, • analytisch hergeleitete Lösungen mit Simulationen im Zeitbereich abzugleichen, • errechnete Ergebnisse eigenständig auf ihre Plausibilität hin zu bewerten; ; ;
(Study-Specific) Prerequisites	keine
(recommended) Requirements	None
References	• ● Hering, Ekbert; Bressler, Klaus; Gutekunst, Jürgen: "Elektronik für Ingenieure", 2. Auflage; VDI-Verlag; Düsseldorf, 1994; ISBN 3-18-401354-5 ● Hering, Ekbert; Martin Rolf; Stonrer, Martin, "Physik für Ingenieure", 6. Auflage; Springer Verlag, 1997; ISBN 3-540-62442-2 ● Ameling, Walter, "Grundlagen der Elektrotechnik I", Bertelsmann Universitätsverlag, 1974, ISBN 3-571-19149-8 ● Ameling, Walter, "Grundlagen der Elektrotechnik II", Bertelsmann Universitätsverlag, 1974, ISBN 3-571-19150-1 ● Möller, Klaus, "Grundgebiete der Elektrotechnik III", 5. Auflage, Verlag der Augustinus Buchhandlung, 1993, ISBN 3-86073-171-8 ● Bell, David A., "Fundamentals of Electric Circuits", 4. Auflage, Preston Publishing Company, Inc., 1988, ISBN 0-13-336645-6 ● Unbehauen, Rolf, "Grundlagen der Elektrotechnik 1", Springer-Verlag ● Mohan,

	Ned; Undeland, Tore M.; Robbins William P., "Power Electronics", 2. Auflage, John Wiley &;;; Sons, Inc., 1995, ISBN 0-471-58408-8 ● Tietze U., Schenk Ch., "Halbleiter-Schaltungstechnik", 11. Auflage, Springer-Verlag, 1999, ISBN 3-540-64192-0 ● Papula, Lothar, "Mathematik für Ingenieure und Naturwissenschaftler - Band 2", 7. Auflage, Vieweg Verlag, 1994, ISBN 3-528-64237-8 ● Eisbein, Jürgen, *Grundstudium Höhere Mathema-tik III - Theorie und Aufgaben", 1. Auflage, Shaker Verlag, 1991, ISBN 3-86111-009-1
Language	German
Examination Terms	written examination ;
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. ir. Dr. h. c. Rik W. De Doncker
ECTS Credits	8
Contact time (WSH)	6
Examination duration (min)	120
Total hours (h)	240,0
Contact hours (h)	90,0
Self-study hours (h)	150,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise exam Fundamentals of Electrical Engineering 2 - Modeling and Analysis of Electrical Components and Circuits (601555502)	4th semester	no semester recommended	0	0
Exam Fundamentals of Electrical Engineering 2 - Modeling and Analysis of Electrical Components and Circuits (601555501)	4th semester	no semester recommended	8	0

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Craft Course	4th semester	no semester recommended	-	0
Lecture and Exercise Fundamentals of Electrical Engineering 2 - Modeling and Analysis of Electrical Components and Circuits	4th semester	no semester recommended	-	4

Small group exercise Fundamentals of Electrical Engineering 2 - Modeling and Analysis of Electrical Components and Circuits	4th semester	no semester recommended	-	2

Module titel	Communications Engineering (Compulsory elective subject)
Identifier	6011238
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2009
Valid until	-
Module level	Bachelor
Content	Sources and channels: entropy and channel capacity – basic channel models: binary symmetric channel, Gaussian channel, fading channel Source coding: discrete and continuous information sources – rate distortion function – entropy coding – quantization and companders – predictive coding – transformation coding – speech and video coding Channel coding: block codes – convolutional codes – algorithms for decoding Digital transmission with low-pass signals: Nyquist criteria – matched filter – equalization – noise characteristics and bit error probabilities Digital transmission with band-pass signals: base-band model – modulation schemes: amplitude shift keying (ASK), phase shift keying (PSK), DPSK, QPSK, QAM and frequency shift keying (FSK) – coherent and incoherent reception Analog transmission schemes: amplitude modulation (AM) and frequency modulation (FM) – demodulation and behavior with noise Multiplex and multiple access: time multiplex – frequency multiplex – code division multiple access (CDMA) – orthogonal frequency division multiplex (OFDM)
Learning Objectives/ Learning Outcomes	After successful completion of this course students have the expertise to ● understand fundamental mechanisms and schemes for information transmission over noisy channels, ● identify theoretical sounds of information transmission, ● master confidently the fundamental principles and different concepts of digital and analog information transmission, ● design, model and analyze communication systems
(Study-Specific) Prerequisites	None.
(recommended) Requirements	● Knowledge and compentencies from the modules Schaltungstechnik 1, Grundgebiete der Elektrotechnik 3 und 4
References	● Ohm/Lüke: Signalübertragung (Bd.2 der 11. Auflage 2007), Springer-Verlag ● Lindner: Informationsübertragung, Springer 1995 ● Vary/Martin: Digital Speech Transmission, Wiley, 2006 ● Bossert: Kanalcodierung, Teubner Verlag, 1998 ● Kammeyer: Nachrichtenübertragung, Teubner Verlag, 2004
Language	German
Examination Terms	written examination (90 minutes)
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr.-Ing. Peter Jax
ECTS Credits	6

Contact time (WSH)	3
Examination duration (min)	90
Total hours (h)	180,0
Contact hours (h)	45,0
Self-study hours (h)	135,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Communications Engineering (601123801)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture and Exercise Communications Engineering	5th semester	no semester recommended	-	3

Module titel	Power Systems (Compulsory elective subject)
Identifier	6011232
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2009
Valid until	-
Module level	Bachelor
Content	The module provides a basic understanding of electric power systems and their components. The main topics of the module are: ● Stationary analysis of symmetric systems ● Transformers including neutral point treatment ● Overhead lines and cables ● Generators and Consumers ● Power flow calculation ● Short circuit calculation (symmetric) ● Network reduction
Learning Objectives/ Learning Outcomes	The successful participation in the module Electric Power Systems enables the students to understand and analyse the central elements, characteristics and the structure of electric power systems in the categories generation, transmission and distribution. The students are able to independently develop mathematical models for the description of electric power systems in a stationary and symmetric state and to apply load flow, network reduction and short circuit calculations on these models. For this purpose, the students apply the knowledge acquired in the lecture about system components such as transformers, overhead lines, cables, generators and consumers.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	● Knowledge and competences provided in the modules Circuit Technology 1 and Basics of Electrical Engineering 3 and 4
References	● Hütte, Taschenbuch der Technik, Elektrische Energietechnik Band 3 (Netze), Springer Verlag ● Happoldt, H.; Oeding, D. Elektrische Kraftwerke und Netze, Springer Verlag ● Heuck, K.; Dettmann K.-D.; Schulz, D. Elektrische Energieversorgung – Erzeugung, Übertragung und Verteilung elektrischer Energie für Studium und Praxis, Vieweg &; Sohn Verlag ● Herold, G. Elektrische Energieversorgung I – Drehstrom – Leistung - Wirtschaftlichkeit J., Schlembach Fachverlag ● Herold, G. Elektrische Energieversorgung II – Parameter elektrischer Stromkreise, Freileitungen und Kabel, Transformatoren, J. Schlembach Fachverlag ● Herold, G. Elektrische Energieversorgung III – Drehstrommaschinen, Sternpunktbehandlung, Kurzschlussströme, J. Schlembach Fachverlag ● Schwab, A. J.: Elektroenergiesysteme – Erzeugung, Transport, Übertragung und Verteilung elektrischer Energie, Springer-Verlag ● Hosemann, G. Elektrische Energietechnik - Band 3: Netze Berlin: Springer Verlag
Language	German
Examination Terms	written examination (90 minutes)
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr.-Ing. Albert Moser

– Applied Courses
– Electrical Engineering
+ Power Systems (6011232)

ECTS Credits	6
Contact time (WSH)	3
Examination duration (min)	90
Total hours (h)	180,0
Contact hours (h)	45,0
Self-study hours (h)	135,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Power Systems (601123201)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture and Exercise Power Systems	5th semester	no semester recommended	-	3

Module titel	Fundamentals of Integrated Circuits and Systems (Compulsory elective subject)
Identifier	6011237
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2009
Valid until	-
Module level	Bachelor
Content	Fundamentals of technology for integrated circuits, bipolar circuits, CMOS circuits: waver manufacturing, fundamentals and forms of photolithography, etching, doping by diffusion and ion implantation, metallization, interconnect ¬technology, process as illustrated by a CMOS ¬inverter; design of analog and digital basic building blocks, geometric and electric design considerations, computer-aided design (CAD), cost considerations and quantitative architecture and circuit improvement, fundamentals of micro system engineering.
Learning Objectives/ Learning Outcomes	Nach erfolgreicher Teilnahme an den Modulveranstaltungen sind die Studierenden in der Lage, ● moderne Technologien und Abläufe zur Herstellung integrierter Schaltungen zu verstehen, ● die verschiedenen Entwurfsstile und –methoden integrierter Systeme zu verstehen und deren Wechselwirkungen zu begreifen, ● exemplarische digitale und analoge Grundschaltungen zu konzipieren, zu optimieren, zu bewerten und zu verifizieren, ● die elementaren Grundlagen der Mikrosystemtechnik zu beherrschen, ● diverse Technologievarianten im Bereich der Mikrosystemtechnik, der Leistungselektronik und der Photovoltaik adäquat einzusetzen.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	● Kenntnisse und Kompetenzen aus den Modulen Schaltungstechnik 1, Grundgebiete der Elektrotechnik 3 und 4
References	● Y. Taur, „Fundamentals of Modern VLSI Design“, Cambridge ● K. Hoffman, “System Integration”, Wiley ● J.M. Rabaey, “Digital Integrated Circuits”, Prentice Hall
Language	German
Examination Terms	written examination (90 minutes)
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr.-Ing. Stefan Heinen
ECTS Credits	6
Contact time (WSH)	3
Examination duration (min)	90
Total hours (h)	180,0
Contact hours (h)	45,0

Self-study hours (h)	135,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Fundamentals of Integrated Circuits and Systems (601123701)	5th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture and Exercise Fundamentals of Integrated Circuits and Systems	5th semester	no semester recommended	-	3

Module titel	Manufacturing Processes for Silicon Based Microsystems (Compulsory elective subject)
Identifier	6011249
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Summer semester 2020
Valid until	-
Module level	Bachelor
Content	cleanroom technology, vacuum technology, fabrication equipment, CMOS process, silicon as a material in microsystems technology, lithography, layer based manufacturing, surface- and bulk micromachining, LIGA fabrication technology, assembly and packaging technologies for microsystems
Learning Objectives/ Learning Outcomes	After successful participation students are able to ● Understand the importance of silicon as a material in microsystems technology ● Describe the design and operating principles of cleanroom facilities ● Understand and explain the fabrication processes of silicon based microsystems ● Understand and explain the processes used for assembly and packaging ● Describe the design and working principles of the necessary machines
(Study-Specific) Prerequisites	None.
(recommended) Requirements	-
References	● S. Büttgenbach, „Mikromechanik“, Teubner Studienbücher ● M. Elwenspoek, „Silicon Micromachining“, Cam-bridge Univ. Pr. ● Heuberger, „Mikromechanik“, Springer-Verlag ● M. Madou, „Fundamentals of Microfabrications“, CRC Press ● W. Menz, P. Bley, „ Mikrosystemtechnik für Inge-nieure“, VCH-Verlagsgesellschaft ● G. Schumicki, „Prozesstechnologie“, Springer-Verlag ● S. M. Sze, „VLSI Technology“, Mac Graw Hill ● S. M. Sze, „Physiks of Semiconductor Devices“, John Wiley &; Sons ● H. Xiao, "Introduction to Semiconductor Manufacturing Technology", Prentice Hall
Language	German
Examination Terms	Written examination (90 min) or oral examination (30 min)
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. rer. nat. Wilfried Mokwa
ECTS Credits	6
Contact time (WSH)	3
Examination duration (min)	90 oder 30
Total hours (h)	180,0
Contact hours (h)	45,0
Self-study hours (h)	135,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Manufacturing Processes for Silicon Based Microsystems (601124901)	6th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture and Exercise Manufacturing Processes for Silicon Based Microsystems	6th semester	no semester recommended	-	3

Module titel	Information Transmission (Compulsory elective subject)
Identifier	6011252
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Summer semester 2020
Valid until	-
Module level	Bachelor
Content	Methods of binary transmission: correlation received for AWGN channels; intereference; Nyquist criterion; binary transmission using lowpass signals (unipolar and bipolar); multilevel transmission; transmission using orthogonal carrier signals; line encoding; channel rectification; binary transmission using bandpass signals; demodulation; transmission reception in the lowpass domain; coherent and incoherent demodulation; Rice distribution and Rayleigh distribution; quadrature modulation; synchronization; disturbances Analog transmission: Pulse amplitude modulation; amplitude modulation; angle modulation; reception and disturbances Multiplex transmission systems: time multiplex; frequency multiplex; code multiplex; direct sequence CDMA; code sequences for synchronous and asynchronous reception; frequency hopping; receiver concepts (Rake, MUD); orthogonal frequency division multiplex (OFDM); diversity; MIMO, space-time codes Transmission boundaries: discrete and continuous signal source signals; signal conversion by pulse code modulation (PCM), impact on disturbance response; rate distortion function, channel capacity and Shannon bound; bandwidth efficiency; bandwidth expansion; interaction and combination of source coding, channel coding, and modulation
Learning Objectives/ Learning Outcomes	Upon successful completion of the course, the students are able ● to understand the fundamentals of analog and digital transmission using carrier signals, as well as corresponding receiver concepts for optimum detection and demodulation, ● to describe the impact of disturbance response of transmission channels on the quality of reception of the respective source signal, ● to apply statistical methods for optimization of communication system components (e.g. quantizer, receiver), ● to understand the basic principles and interaction of the components of modern transmission systems.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Knowgledge and competences as acquired in the lecture Grundgebiete der Elektrotechnik 3 – Signals and Systems.
References	● Ohm/Lüke: Signalübertragung (12. Auflage 2014), Teil B (Kapitel 8-14), Springer-Verlag ● Lindner: Informationsübertragung, Springer 1995 ● Proakis: Digital Communications, McGraw-Hill ● Proakis and Salehi: Communication Systems Engineering, Prentice-Hall
Language	German
Examination Terms	written examination (90 minutes)
Miscellaneous	-

Module coordinator	Universitätsprofessor Dr.-Ing. Jens-Rainer Ohm
ECTS Credits	6
Contact time (WSH)	3
Examination duration (min)	90
Total hours (h)	180,0
Contact hours (h)	45,0
Self-study hours (h)	135,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Information Transmission (601125201)	6th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture and Exercise Information Transmission	6th semester	no semester recommended	-	3

Module titel	Introduction to Acoustics (Compulsory elective subject)
Identifier	6011253
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Winter semester 2019
Valid until	-
Module level	Bachelor
Content	Introduction into the fundamentals of sound propagation and sound field modelling, acoustic measurementsm recording and reproduction technology, anatomy and physiology of human hearing psychoacoustics, 3D sound
Learning Objectives/ Learning Outcomes	The students should get a fundamtental understanding of acoustics in various areas: ● Acoustics and interaction with human perception ● Acoustics in engineering sciences (electrical, automotive, architecture) ● Acoustics in measurement in audio and media technology
(Study-Specific) Prerequisites	None.
(recommended) Requirements	-
References	will be announced in the lecture.
Language	German
Examination Terms	written examination (90min) or oral examination (30min)
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. rer. nat. Michael Vorländer
ECTS Credits	6
Contact time (WSH)	3
Examination duration (min)	90 oder 30
Total hours (h)	180,0
Contact hours (h)	45,0
Self-study hours (h)	135,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Introduction to Acoustics (601125301)	6th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture and Exercise Introduction to Acoustics	6th semester	no semester recommended	-	3

RWTH AACHEN UNIVERSITY

Module titel	High and Medium Voltage Switchgears (Compulsory elective subject)
Identifier	6011245
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Winter semester 2019
Valid until	-
Module level	Bachelor
Content	The lecture and exercise is about the switchgear used in medium- and high-voltage grids as well as their construction and application. Current operating experience with innovative system technology and contributions from external speakers complement the lecture with practical aspects. Considered resources: ● SF6 circuit breakers ● Vacuum switches ● High-voltage high-power fuses ● Power cables and overhead lines ● Power Transformers ● High-voltage DC transmission ● High / medium voltage switchgear
Learning Objectives/ Learning Outcomes	With successful participation, the students have acquired an overview of the structure and functionality of components and systems for energy transmission and distribution. Further, the students are capable of explaining the structure of electrical networks of the various voltage levels and name the different relevant components. Regarding the components, the students are able to identify different types of SF6 circuit breakers and to describe the current interrupting feature in technical detail. They know the technically meaningful application areas of SF6 circuit breakers and can differentiate them from application areas of vacuum circuit breakers. The students can explain the design and technical functionality of the individual components and assemblies of vacuum breakers. They are capable of qualitatively describing the physical processes in the vacuum switch when a short-circuit current is switched off. The students can name the different types of high-voltage high-power fuses and explain their characteristic differences and applications. They are able to describe the design and the purpose of the fuse components with the help of real fuse samples. Students can explain the switching process and current-limiting feature of fuses in case of short-circuit or overload currents. Students can name power cables and overhead lines as components for the transmission and distribution of electrical energy and know their specific technical advantages and disadvantages when used in low, medium and high voltage. Using an energy cable sample, the students can name the structure and the function of the individual layers. They are able to explain the structure of overhead line conductors and the technical reason to use different materials (aluminum and steel) for the construction. The students can reflect the purpose, the physical principle and construction of power transformers. They are able to sketch the structure of the active part schematically and can describe and justify the structure and the arrangement of the individual assemblies. The students know the basic parameters (voltage levels, converter principles, currents, line management) of today's technologies for high-voltage direct current transmission. They can name and justify advantages and disadvantages of the technology compared to three-phase current technology. Using cross-sectional sketches of gas-insulated medium-voltage switchgear, the students can name the components and their respective function.
(Study-Specific) Prerequisites	-

(recommended) Requirements	-
References	● Klaus Heuck, Klaus-Dieter Dettmann; Detlef Schulz, Elektrische Energieversorgung / Erzeugung, Übertragung und Verteilung elektrischer Energie für Studium und Praxis, Vieweg +Teubner Verlag, 2007. ● M. Beyer, W. Beck, K. Möller, W. Zaengl, Hochspannungstechnik, Springer ● A. Küchler, Hochspannungstechnik, Springer ● Gremmel, Hennig (Hrsg.): Schaltanlagen ABB Calor Emag, Taschenbuch.
Language	German
Examination Terms	oral examination (30 min) or written examination (90 min)
Miscellaneous	-
Module coordinator	Univ.-Prof. Dr. Ir. Willem Leterme
ECTS Credits	6
Contact time (WSH)	3
Examination duration (min)	90 oder 30
Total hours (h)	180,0
Contact hours (h)	45,0
Self-study hours (h)	135,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam High and Medium Voltage Switchgears (601124501)	6th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture and Exercise High and Medium Voltage Switchgears	6th semester	no semester recommended	-	3

Module titel	Fundamentals of Electrical Engineering 3 - Signals and Systems (Compulsory elective subject)
Identifier	6011114
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2017
Valid until	-
Module level	Bachelor
Content	Examples of electrical systems: Stationary excitation by AC voltage sources, switched DC and AC voltage sources; Signals and systems: elementary signals, definition of systems, linear time-invariant systems, the convolution integral, examples for calculation of the convolution integral, convolution algebra, Dirac impulse, integration and differentiation of signlas, causal and stable systems, energy and power of signals; Laplace transform: The Laplace integral, analysis of convergence of the Laplace transform, examples for the Laplace transform, poles and zeros in the complex Laplace plane, inverse Laplace transform, solving differential equations using the Laplace transform, stability analysis of systems, system analysis and synthesis using the Laplace transform, tables of Laplace transform pairs; Fourier analysis: Eigenfunctions of LTI systems, Fourier series, the Fourier integral, theorems on the Fourier Transform, examples for application of the theorems, tables of Fourier transform pairs; Description of signals and systems in time and frequency domain: distortion-free systems, parameters for characterization of transmission properties, lowpass systems, highpass and bandpass systems; Discrete-time signals and systems: sampling in the time domain, discrete-time signals and systems, discrete-time convolution, Fourier transform of discrete time signals, the discrete-time Fourier transform, z transform, discrete-time lowpass, bandpass, and highpass filters, tables of Fourier and z transform pairs; Correlation analysis: Energy signals and power signals – orthognality, cross correlation, autocorrelation, convolution and energy spectral density – correlation analysis of discrete-time signals; Statistical description of signals: Random signals – stationarity and ergodicity – mean values, correlation functions, moments and power spectra of stationary processes – random signals and LTI systems, white noise – distribution functions and probablility density functions – the Gaussian distribution – discrete-time random signals – quantization and quantization noise – quantizer characteristics, discrete density functions;
Learning Objectives/ Learning Outcomes	Upon successfuly participation in the module courses the students ● Have a basic comprehensive knowledge about abstract description of electrical systems behaviour using methods of system theory ● Capture the description of signals and systeme in time and frequency domain, including the relation between these domains ● Understand the relation between continuous-time and discrete-time processes based on the sampling operation ● Are able to apply Laplace and z transforms for analysis and synthesis of systems ● Gained an initial understanding of statistical signal analysis methods
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Knowledge and competences as acquired in the lectures Grundgebiete der Elektrotechnik 1 and Grundgebiete der Elektrotechnik 2 are required.
References	● Ohm/Lüke: Signalübertragung, 12. Auflage, 2014, Teil A (Kapitel 1-7), Springer Verlag ● Girod, Rabenstein und Stenger: Einführung in die Systemtheorie, 3. Auflage, Teubner-Verlag

	• Oppenheim, Willsky and Young: Signals and Systems, 3rd edition, Prentice-Hall
Language	German
Examination Terms	written examination (90 minutes)
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr.-Ing. Jens-Rainer Ohm
ECTS Credits	8
Contact time (WSH)	6
Examination duration (min)	90
Total hours (h)	240,0
Contact hours (h)	90,0
Self-study hours (h)	150,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise exam Fundamentals of Electrical Engineering 3 - Signals and Systems (601111402)	6th semester	no semester recommended	0	0
Exam Fundamentals of Electrical Engineering 3 - Signals and Systems (601111401)	6th semester	no semester recommended	8	0

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Small group exercise Fundamentals of Electrical Engineering 3 - Signals and Systems	6th semester	no semester recommended	-	0
Lecture and Exercise Fundamentals of Electrical Engineering 3 - Signals and Systems	6th semester	no semester recommended	-	6

Module titel	Special-Purpose Operating Systems (Compulsory elective subject)
Identifier	6010394
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Winter semester 2023
Valid until	-
Module level	Master

Content	General-purpose operating systems have the advantage that they are widely used and established.
	
	However, they cannot adequately meet the needs of specialty areas. In this lecture, we will learn how
	
	operating systems are redesigned or adapted to achieve better performance in specialized areas. Here,
	
	the focus is on the areas of "high-performance computing", "real-time processing" and "cloud
	
	computing". The topics are structured as follows:
	
	• Introduction
	    • General purpose operating systems and their design goals
	    • Design goals in the areas of real-time processing, high-performance computing, and cloud computing.
	• Real-Time Processing
	    • Definition of real-time systems
	    • Planning procedures for real-time systems
	    • Real-time interrupt handling
	    • Micro-kernel architectures
	    • Case studies: e.g. Real-Time Linux, OSEK/VDK
	• High performance computing
	    • Evaluation criteria, benchmarks
	    • Hardware for HPC
	        • Memory interfacing: cache consistency and coherence; NORMA, UMA, NUMA.
	        • Heterogene Systeme
	    • Consequences for system software
	        • Adaptation of planning procedures
	        • Strategies for data placement
	        • File systems for the HPC
	        • Techniques to increase scalability
	    • Multi-Kernel architectures
	    • Case studies: mOS, Kitten, Catmount, etc.
	• Cloud Computing
	    • Definition, areas of application
	    • Virtualization techniques
	        • Virtualization at the operating system level (containers)
	        • Virtual machines
	        • Para-virtualization
	    • Orchestration of virtual instances
	    • Unikernels architectures
	    • Case studies: including Kata containers, Docker, Kubernetes.

Learning Objectives/ Learning Outcomes	After successful participation in the module events, the students are able • to understand the modeling of special operating systems as well as their technical fundamentals and to apply different evaluation approaches to these systems,

	• to master and to apply the principles of high-performance computing, real-time processing, and computing, • to analyze and to evaluate specialized system designs, • to independently apply the acquired skills and to develop scalable services.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Participation in a system-oriented lecture (e.g., "Operating Systems")
References	• Stallings, W.: Operating Systems: Internals and Design Principles, Prentice Hall, 2014. • Andrew S. Tanenbaum and Herbert Bos: Modern Operating Systems, Pearson Education International, 2014 • Abraham Silberschatz and Peter Baer Galvin and Greg Gagne: Operating System Concepts, John Wiley &; Sons, 2013 • Bakazs Gerofi, Yutaka Ishikawa, Rolf Riesen, Robert W. Wisniewski: Operating Systems for Supercomputers and High Performance Computing, Springer, 2019 • Jane W. S. Liu: Real-Time Systems, Pearson, 2000 • T. Anderson and M. Dahlin, Operating Systems – Principles and Practice. Recursive Books, 2015
Language	English
Examination Terms	written exam
Miscellaneous	-
Module coordinator	Dr. rer. nat. Stefan Lankes
ECTS Credits	4
Contact time (WSH)	3
Examination duration (min)	90
Total hours (h)	120,0
Contact hours (h)	45,0
Self-study hours (h)	75,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Special-Purpose Operating Systems (601039401)	3rd semester	no semester recommended	4	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture and Exercise Special-Purpose Operating Systems	3rd semester	no semester recommended	-	3

Module titel	Physics lab (Compulsory elective subject)
Identifier	1316338
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Summer semester 2017
Valid until	-
Module level	Bachelor
Content	Basic quantities of physics and physical laws, mechanics, oscillations and waves, electromagnetism, optics, atomic physics.
Learning Objectives/ Learning Outcomes	Knowledge / Understanding Students will be able to explain and present the fundamentals of classical physics. This includes the experimental approach based on selected experiments, the mathematical formalization of physical phenomena and the use of basic equations for specific applications. Application / Analysis In the practical course, students acquire simple experimental skills. They know the basic principles of data acquisition, evaluation and interpretation and apply these to experimental physical problems. Synthesis / Assessment The understanding of selected physical phenomena is further developed through experiments and students are able to use what they have learned for their further studies. In group work, the ability to work in a team is promoted through the joint or individual development of scientific content and its written documentation. ;
(Study-Specific) Prerequisites	-
(recommended) Requirements	none
References	-
Language	German
Examination Terms	none
Miscellaneous	-
Module coordinator	Heidrun Heinke
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	0
Total hours (h)	180,0

Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Laboratory Work (Physics) (131633801)	6th semester	no semester recommended	6	4

Module titel	Physics II for Students of Sciences, Mathematics, Computer Science and Engineering (Compulsory elective subject)
Identifier	1310567
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Winter semester 2022
Valid until	-
Module level	Bachelor/Master
Content	Schwingungen und Wellen, Elektrostatik, elektrischer Transport, Magnetismus, Elektrodynamik, Elektronik, Optik
Learning Objectives/ Learning Outcomes	Den Studierenden werden die Grundlagen der klassischen Physik vermittelt. Dies umfasst den experimentellen Zugang, der anhand von Demonstrationsexperimenten dargestellt wird, die mathematische Formalisierung physikalischer Phänomene in Grundgleichungen sowie den Umgang mit Grundgleichungen bei spezifischen Anwendungen. Letzteres wird in Übungen gezielt gefördert und ist wesentlicher Bestandteil der Abschlussklausur. Aufbauend auf der Beschreibung von Schwingungs- und Wellenphänomenen wird das gesamte Gebiet des Elektromagnetismus sowie eine rudimentäre Einführung in die Optik abgehandelt.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Keine
References	Halliday, Resnick, Walker: Physik; Tipler: Physik
Language	German
Examination Terms	Zulassung zur Modulprüfung: Lösen von Übungsaufgaben. Modulprüfung: Bestehen einer Klausur; Prüfungsdauer wird am Anfang des Semesters bekannt gegeben.
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Modulangebotsverantwortlicher Physik Modellierungsteamverantwortlicher: Dr. rer. nat. Katja Petzoldt Modulverantworlicher: Universitätsprofessor Dr. rer. nat. Markus Morgenstern
ECTS Credits	8
Contact time (WSH)	6
Examination duration (min)	0

Total hours (h)	240,0
Contact hours (h)	90,0
Self-study hours (h)	150,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Physics II for Students of Sciences, Mathematics, Computer Science and Engineering (131056702)	4th semester	no semester recommended	0	2
Exam Physics II for Students of Sciences, Mathematics, Computer Science and Engineering (131056701)	4th semester	no semester recommended	8	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Physics II for Students of Sciences, Mathematics, Computer Science and Engineering	4th semester	no semester recommended	-	4

Module titel	Physics I for Students of Sciences, Mathematics, Computer Science and Engineering (Compulsory elective subject)
Identifier	1315740
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2006
Valid until	-
Module level	Master
Content	Messgrößen, Punktmechanik, Kräfte, Erhaltungssätze, ausgedehnte Körper, Drehbewegungen, Scheinkräfte, Elastizität, Hydrostatik und -dynamik, kinetische Gastheorie, Thermodynamik
Learning Objectives/ Learning Outcomes	Den Studierenden werden die Grundlagen der klassischen Physik vermittelt. Dies umfasst den experimentellen Zugang, der anhand von Demonstrationsexperimenten dargestellt wird, die mathematische Formalisierung physikalischer Phänomene in Grundgleichungen sowie den Umgang mit Grundgleichungen bei spezifischen Anwendungen. Letzteres wird in Übungen gezielt gefördert und ist wesentlicher Bestandteil der Abschlussklausur. Aufbauend auf der Bewegung von Massenpunkten wird das Konzept der Schwerpunkts- und Drehbewegungen sowie die Beschreibung von Vielteilchensystemen im Rahmen der Strömungs- und Thermodynamik dargestellt.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Keine
References	Halliday, Resnick, Walker: Physik; Tipler: Physik
Language	German
Examination Terms	Zulassung zur Modulprüfung: Lösen von 50% der Übungsaufgaben. Modulprüfung: Bestehen einer Klausur; Prüfungsdauer wird am Anfang des Semesters bekannt gegeben
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Modulangebotsverantwortlicher Physik Modellierungsteamverantwortlicher: Dr. rer. nat. Katja Petzoldt Modulverantworlicher: Universitätsprofessor Dr. rer. nat. Markus Morgenstern
ECTS Credits	8
Contact time (WSH)	6
Examination duration (min)	0

Total hours (h)	240,0
Contact hours (h)	90,0
Self-study hours (h)	150,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Physics I for Students of Sciences, Mathematics, Computer Science and Engineering (131574002)	3rd semester	no semester recommended	0	2
Exam Physics I for Students of Sciences, Mathematics, Computer Science and Engineering (131574001)	3rd semester	no semester recommended	8	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Physics I for Students of Sciences, Mathematics, Computer Science and Engineering	3rd semester	no semester recommended	-	4

Module titel	Biology as a Subsidiary Subject I (Compulsory elective subject)
Identifier	1631077
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2024
Valid until	-
Module level	Bachelor
Content	This module explains the general principles of biology. The first part of the lecture addresses what is meant by the term "life." The chemical foundations of life are discussed, and the significance of anabolic and catabolic metabolic pathways is explained. Building on this, the cell is described as the building block of living organisms. The differences in cell structure between prokaryotes, fungi, plants, and animals (eukaryotes) are elucidated, and the various cell organelles are described. Subsequently, the process of cell division is also explained. Next, genetics is covered, explaining how DNA and RNA are structured and how gene expression (transcription and translation) is regulated. An introduction to biotechnological applications provides insight into modern genetic analysis methods. Building on this, it is explained how mutations and genome duplications can explain the process of evolution and changes in allele frequency in a population (microevolution). Furthermore, it is described how the various life forms on Earth originated and evolved (macroevolution). This includes a discussion of the anatomical, morphological, and physiological characteristics of microorganisms, plants, and animals. Various adaptations of life forms to their living and environmental conditions are addressed. Microorganisms are examined in terms of their pathogenic properties, as well as their ecologically vital roles, such as in the nutrient cycles of the Earth. In the area of plants, the functional anatomy and morphology of different plant groups are discussed, as well as processes such as photosynthesis and the transport of assimilates from root to shoot. Flower biology and pollination mechanisms are also covered. In the zoological section, the various animal groups are briefly introduced, and the physiology of the most important organs is explained (heart, lungs, nervous and sensory systems, hormones, muscles). In the field of ecology, general ecological principles are explained, such as biodiversity and its distribution, basic principles of biogeography, and the functioning of ecosystems. Abiotic environmental factors and their effects on organisms, including their adaptations, are presented. Building on this, the parameters and dynamics of biological populations, as well as predator-prey interactions in ecological models, are discussed. Finally, the structure and distribution of communities in habitat types are explained using the example of forests, open land habitats, and urban environments.
Learning Objectives/ Learning Outcomes	After successful completion of the course, students are able to explain the key principles and mechanisms of biochemistry, cell biology, genetics, microbiology, botany, zoology, evolution, and ecology (see "Content"). Students outline the structure and function of various biological macromolecules and explain their significance for metabolism in cells and organs. They highlight the differences between prokaryotes and eukaryotes as well as between animal and plant cells, explaining the resulting consequences. They also outline the structure and function of biomembranes and organelles, emphasizing the dependence of structure on function and applying these principles. Students explain the fundamentals of inheritance. They also understand the molecular foundations of genetics and can explain key processes (replication, gene expression). Students understand that recombination and mutation are the basis for genetic variability. Students categorize the plant kingdom into its main groups (algae, mosses, ferns, flowering plants). They describe the various plant organs (root, stem, leaf, flower, and fruits) and fundamental plant physiological processes such as photosynthesis, nutrient transport, growth, and development. Students can classify major groups of the animal kingdom in the phylogenetic tree and have acquired basic knowledge of the functions of important organs. Students understand the relevance of environmental quality in a societal context. Based on an ecosystem approach, they comprehend specific ecological examples and are aware of their responsibility in this area. Students know the principles of evolution and explain simple applications. They describe adaptation strategies to habitats.

– Applied Courses
– Biology
+ Biology as a Subsidiary Subject I (1631077)

(Study-Specific) Prerequisites	The module "Biology for Students of Computer Sciences and Mathematics" (1612784) must not be completed successfully.
(recommended) Requirements	none
References	Campbell Biology
Language	German
Examination Terms	The module grade is the grade of the written exam.
Miscellaneous	-
Module coordinator	Prof. Dr. JT van Dongen
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	90
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Biology as a Subsidiary Subject I (163107701)	3rd semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Biology as a Subsidiary Subject I	3rd semester	no semester recommended	-	4

Module titel	Biology as a Subsidiary Subject III (Compulsory elective subject)
Identifier	1631079
Version	V1
Duration (Semester)	two semesters
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2024
Valid until	-
Module level	Bachelor
Content	The module consists of three practical parts: practical course microbiology and genetics, practical course plant physiology and practical course animal physiology. In this module, students perform, evaluate, record, and interpret wet lab experiments on various central topics in biology. In the practical course in microbiology and genetics, basic microbiological and molecular biological techniques are taught in theory and practice. This includes sterile working techniques, handling of basic microbiological and molecular biological work equipment, microscopy of microorganisms, and various methods of culturing microorganisms. In addition, experiments are performed to test phenotypic, metabolic and physiological properties of microorganisms, a method to determine cell titre, a polymerase chain reaction to amplify a vector fragment, restriction analysis of a DNA vector, transformation of Escherichia coli and sexual hybridization of the yeast Saccharomyces cerevisiae. The experiments are evaluated, recorded and interpreted. In the practical course in plant physiology the experiments will cover physiological and biochemical topics, such as enzymatics, photosynthesis and stress reactions. Furthermore, molecular biological methods for cloning and amplification of DNA are applied. The practical part of animal physiology gives students the opportunity to experimentally explore various aspects of animal physiology in four experiments. The experiments include simulations of action potentials, virtual experiments on the heart, and experiments on blood and respiration.
Learning Objectives/ Learning Outcomes	After completion of the module, students will be able to perform independent and autonomous experiments with microbiological, plant and animal test material, including material preparation and microscopy. They will have acquired basic skills in experimental work and data analysis. They are not only able to perform scientific experiments independently, but also to document and analyze them. After successful completion of the practical course in microbiology and genetics, students will be able to independently perform basic microbiological techniques such as sterile work, pipetting, cultivation and microscopy of microorganisms. They will select and apply methods to test the metabolic and physiological properties of microorganisms for differentiation or identification. Students know the advantages and disadvantages of different quantification options for microorganisms and select and perform them according to the situation. Independently perform basic molecular biology techniques such as polymerase chain reactions, restriction analysis, transformations and hybridizations of lower eukaryotes. Students are able to present, critically evaluate and interpret the results of the experiments independently and correctly from a scientific point of view. After completing the practical course in plant physiologie the students wiil be able to perform basic experiments on biochemical, plant physiological and molecular biological questions, evaluate them and interpret the results. The students know possibilities including the advantages and disadvantages of different forms of presentation of experimental results and select them purposefully. After successful completion of the practical course in animal physiology, students will be able to perform, evaluate and document basic experiments in animal physiology. They will have deepened their knowledge from the lecture and will be able to apply it in practice. Students will be able to measure and interpret physiological parameters using simulations and human experiments.

(Study-Specific) Prerequisites	Successful participation in the module Biology as a Subsidiary Subject I is a prerequisite for participation.
(recommended) Requirements	It is assumed that the subject content from the first two parts (Biology as a Subsidiary Subject I +II) is known and can be applied.
References	Steinbüschel, A., Oppermann-Sanio, F.B., Ewering, C., Pötter, M.: Mikrobiologisches Praktikum. Springer Spektrum; Slonczewski, J.L., Foster, J.W.: Mikrobiologie – Eine Wissenschaft mit Zukunft. Springer Spektrum Müller WA, Frings S, Möhrlen F (2015) Tier- und Humanphysiologie: Eine Einführung, 5. Auflage, Springer Spektrum Gründer S, Schlüter K-D (2019) Physiologie hoch2, 1. Auflage, Elsevier Hildebrandt JP, Bleckmann H, Homberg U (2014) Penzlin - Lehrbuch der Tierphysiologie, 8. Auflage, Springer Spektrum Urry LA, Cain ML, Wasserman SA, Minorsky PV, &; Reece JB (2019) Campbell Biologie 11. Auflage. Hallbergmoos, Deutschland: Pearson Studium
Language	German
Examination Terms	To pass the module, active participation in the practical courses is required and checked this includes, among other things, conscientious preparation and followup of the practical course days. The criteria for active participation will be announced at the beginning of the practical courses via CMS (Moodle). Attendance is compulsory in the practical courses. A maximum absence of 10% per practical course is allowed. The module is ungraded.
Miscellaneous	-
Module coordinator	Prof. Dr. JT van Dongen
ECTS Credits	8
Contact time (WSH)	4
Examination duration (min)	-
Total hours (h)	240,0
Contact hours (h)	60,0
Self-study hours (h)	180,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Practical Course Microbiology and Genetic (163107901)	4th semester	no semester recommended	4	2
Practical Course Plant Physiology (163107902)	5th semester	no semester recommended	2	1
Practical Course Animal Physiology (163107903)	5th semester	no semester recommended	2	1

Module titel	Biology as a Subsidiary Subject II (Compulsory elective subject)
Identifier	1631078
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Winter semester 2024
Valid until	-
Module level	Bachelor
Content	In the module, the basics and mechanisms of microbiology, genetics, plant sciences and animal physiology are deepened and possible applications of biology, informatics and mathematics are demonstrated. The modul deals with the morphological, physiological and genetic properties of microorganisms, their diversity and the application of microbes and microbiological techniques in industry and science. Topics include cell morphology, prokaryotic gene transfer processes, differentiation techniques and hybridization of lower eukaryotes. The application examples presented include industrial applications such as beer and wine production, but also genetic and metabolic modification possibilities in research development with a focus on sustainable value creation. In addition, mechanisms, regulation and possible modification approaches of eukaryotic and prokaryotic gene expression as well as basics of epigenetics will be deepened. Basic and advanced molecular biology methods such as PCR, restriction analysis, next generation sequencing, metagenome and transcriptome analysis will be presented. The module provides basic knowledge of photosynthesis, such as light and dark reactions, the Calvin cycle, chlorophyll fluorescence, and photorespiration. It also introduces metabolic processes such as glycolysis, the citrate cycle, respiration and fermentation, as well as the principles of enzyme kinetics, in particular regulation, inhibition and Michaelis-Menten kinetics, and the molecular control mechanisms of hormonal regulation in plants. In addition, an insight into the physiological functions of various human and animal body systems is provided. Beginning with the basics of sensory physiology and the perception of environmental stimuli, information transmission and processing in the brain, the cardiovascular system, and respiration are covered. To understand the role of mathematical and computational methods in biology, the history of applying mathematics is reviewed and mathematical modeling is introduced, tracing its evolution from reductionism to the emergence of systems biology. The application of differential equation-based models across various biological disciplines provides an understanding of the different types of models and their significance in elucidating the dynamics and emergent properties of biological systems. Furthermore, computer models and simulation approaches for modeling biomolecules (DNA, RNA, proteins) are discussed and the mathematical description and accuracy of the simulation methods are discussed. Different models for the simulation of biomolecules are presented, analyzed and evaluated with respect to their applicability and transferability. More detailed examples will be discussed to highlight specific results towards certain applications in the field of biology and biotechnology.
Learning Objectives/ Learning Outcomes	After successfully completing, students will be able to explain and evaluate the application potential of various biological mechanisms and organisms using examples. Students will be able to explain the biochemical, physiological and genetic principles of microbial cells and to assess the potential of the diverse metabolic processes and evaluate the potential of diverse metabolic processes and the relevance of microorganisms for the economy and the environment. They will be able to explain the possibilities of differentiation, the principles of prokaryotic gene transfer processes and eukaryotic segregation analysis

	and point out their application potential. They will be able to outline industrial applications of microbes and assess and explain the application potential of microorganisms and microbiological techniques for a sustainable bio-economy. Students know the molecular basics of genetics and can explain the most important processes. They understand recombination and mutation as the basis of genetic variability and the role of epigenetics in the expression and inheritance of traits. They can explain and apply basic molecular biology techniques. They can explain the methods of NGS, metagenome and transcriptome analysis and evaluate their application potential. Students will have a basic knowledge of the physiological functions of the body systems discussed and will be able to explain them. They have an overview of the interactions of body systems and can make independent connections between physiological functions. They gain an understanding of the coding and transmission of information in the nervous system and can describe the function of the human heart and lungs. Students will be able to describe enzyme kinetics according to Michaelis-Menten and to explain the differences between competitive and allosteric inhibition. They will be able to explain in detail the relationship between solar energy, photosynthesis, energy storage in the form of organic molecules, and cellular respiration. They will understand the theory of chlorophyll fluorescence and its detection methods and be able to apply them to carry out and evaluate experiments. They will also be able to describe the molecular processes of some important phytohormones. Students understand the abstract concept of a model and can provide classical examples of mathematical models of biological systems. They will be able to formulate a differential equation based model to study the dynamics of a biological system. They will be able to apply the principles of enzyme kinetics to describe rates of change in the system. Students understand different approaches and models for the simulation and modeling of biomolecules. In addition, they understand, comprehend and critically apply the elementary principles of modeling biomolecules. They will also be able to contextualize the results of their work. They are familiar with the use of relevant terminology in scientific computing and computational life sciences.
(Study-Specific) Prerequisites	The module Biology as a Subsidiary Subject I must be passed.
(recommended) Requirements	None
References	-
Language	German
Examination Terms	The module grade is the grade of the written exam.
Miscellaneous	-
Module coordinator	Modulbeauftragter: Prof. Dr. Joost van Dongen Modulangebotsorganisation: Kevin Rosar, M.Sc.
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	90 min
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Applied Courses
Biology
Biology as a Subsidiary Subject II (1631078)

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Biology as a Subsidiary Subject II (163107801)	4th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Biology as a Subsidiary Subject II	4th semester	no semester recommended	-	4

RWTHAACHEN UNIVERSITY

Module titel	Engineering Mechanics (Compulsory elective subject)
Identifier	4014421
Version	Angelegt über RWTH API als 1
Duration (Semester)	two semesters
Cycle (Semester)	winter semester
Valid from	Winter semester 2007
Valid until	-
Module level	Bachelor
Content	Technische Mechanik I: Vektoren, Definition von Kraft, Wirkungslinie und Kraftangriffspunkt, graphische Darstellung von Kräften in Lageplänen, Wechselwirkungsgesetz und Schnittprinzip, zentrales Kraftsystem, Zusammenfassung und Zerlegung von Kräften mit gemeinsamem Kraftangriffspunkt, Gleichgewicht zentraler Kraftsysteme, Beispiel einfaches Fachwerk, statisch bestimmte und unbestimmte Systeme, ebenes Kraftsystem, Resultierende von Kräften mit verschiedenen Angriffspunkten, Kräfte mit parallelen Wirkungslinien, Gleichgewicht nichtzentraler Kraftsysteme, räumliche Kraftsysteme, Moment einer Kraft und eines Kräftepaares, Wirkungslinie der Resultierenden, Parallelverschieben einer Kraft, Zusammenfassung von Kräften und Momenten, Gleichgewicht starrer Körper, Reibung, Haftreibung und Gleitreibung, Coulombsches Reibungsgesetz, Reibungskegel, Seilreibung und Riemenantrieb, Kräftemittelpunkt und Schwerpunkt, Schnittlasten in Balken, Rahmen und Wellen, Beziehungen zwischen kontinuierlicher Last, Querkraft und Biegemoment, Darstellung von Schnittlasten, Arbeit von Kräften und Momenten, Prinzip der virtuellen Arbeit, Stabilität und Arbeit, Stabilität der Gleichgewichtslage. Technische Mechanik II: Spannungsvektor, einachsiger und ebener Spannungszustand, Normalspannung und Schubspannung, Mohrscher Kreis, Deformation, Hookesches Gesetz, Dehnung und Scherung, Elastizitäts- und Schubmodul sowie Querkontraktion, räumlicher Spannungszustand, Spannungstensor und Deformationstensor, Verschiebung, Dehnung und Scherung, Volumendehnung, einachsiger Spannungszustand, einachsiger Dehnungszustand, Belastung unter Eigengewicht, Reißlänge, Körper gleicher Festigkeit, statisch bestimmte und unbestimmte Fachwerke, Verschiebung von Knotenpunkten, Verschiebungsplan, Ausnahmefachwerke, Stabdehnung in Fachwerken, Flächentragwerke, gleichförmig belastete Scheibe, zylindrische Kessel (Kesselformeln), Wärmedehnung, Schrumpfsitz, Balkenbiegung, Biegung des geraden Balkens, Biegetheorie nach Euler und Bernoulli, Biegespannung, Krümmungsradius, Flächenträgheitsmoment, Flächenträgheitsmomente einfacher Querschnittsflächen, Deviationsmomente, Ermittlung der Biegelinien verschiedener Balkenkonfigurationen.
Learning Objectives/ Learning Outcomes	Wissen / Verstehen • Die Studierenden sind fähig, die wichtigsten Grundlagen und Theorien aus den Bereichen 'Statik', 'Festigkeitslehre' und 'Dynamik' der Technischen Mechanik zu erklären. Anwenden / Analyse • Mit dem angeeigneten Fachwissen können die Studierenden theoretische Modelle nicht nur anwenden, sondern auch auf aktuelle Fragestellungen übertragen. Synthese / Beurteilen • Die Studierenden sind fähig, einen Sachverhalt nach seinen relevanten technischen und mechanischen Gesichtspunkten aufzugliedern und kritisch zu hinterfragen.

Engineering Mechanics (4014421)

(Study-Specific) Prerequisites	Keine
(recommended) Requirements	Keine Voraussetzungen für die Zulassung zum Modul.
References	-
Language	German
Examination Terms	Bewertung anhand der gewichteten Klausurergebnisse.
Miscellaneous	-
Module coordinator	Dr.-Ing. Bernd Binninger
ECTS Credits	6
Contact time (WSH)	6
Examination duration (min)	-
Total hours (h)	180,0
Contact hours (h)	90,0
Self-study hours (h)	90,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Engineering Mechanics I (401442101)	3rd semester	no semester recommended	3	0
Exam Engineering Mechanics II (401442102)	4th semester	no semester recommended	3	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Engineering Mechanics I	3rd semester	no semester recommended	-	2
Exercise Engineering Mechanics II	4th semester	no semester recommended	-	1
Lecture Engineering Mechanics II	4th semester	no semester recommended	-	2
Exercise Engineering Mechanics I	3rd semester	no semester recommended	-	1

Module titel	Automatic Control (Compulsory elective subject)
Identifier	4012555
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2007
Valid until	-
Module level	Bachelor/Master
Content	1. Einführung: Steuerung und Regelung; Grundstruktur des Regelkreises; Beispiele 2. Modellbildung: Aufstellen von Differentialgleichungen, Zustandsraum, Wirkungsplan 3. Linearisierung: Arbeitspunkte, Linearisieren von Differentialgleichungen, Stabilität 4. Verhalten von Systemen: homogene Lösung, charakteristisches Polynom, Eigenwerte 5. Verhalten bei Anregung: Übergangsfunktion, Gewichtsfunktion, Faltung, Laplace-Transformation, Übertragungsfunktion, Grenzwertsätze 6. Verhalten bei sinusförmiger Anregung: Frequenzgang, Ortskurve, Bode-Diagramm, Fourier-Transformation, Filter 7. Lineare Regelkreisglieder: Verschaltung von Systemen, Zerlegung von Systemen, Grundlegende Reglertypen, Verzögerungsglieder 8. Lineare Regelkreisglieder: Weitere Kombinationen, Totzeitglieder, Minimalphasigkeit, Systemidentifikation 9. Stabilitätsprüfung: Algebraische Stabilitätskriterien, Nyquist-Kriterium, Amplituden- und Phasenreserve 10. Reglerentwurf: Gütemaße, Statische Auslegung, Einstellregeln, Reglerentwurf im Bode-Diagramm 11. Reglerentwurf: Zustandsregler, Steuerbarkeit, Beobachbarkeit, Zustandsbeobachter 12. Vermaschte Regelkreise: Vorsteuerung, Kaskadierte Regelkreise, Störgrößenaufschaltung 13. Zeitdiskrete Systeme: Zeitdiskreter Zustandsraum, Stabilität, Quasikontinuierliche Stabilitätsbetrachtung 14. Kalmanfilter: Zeitdiskrete Systemidentifikation, Kalmanfilter
Learning Objectives/ Learning Outcomes	Wissen und Verstehen: Nach erfolgreicher Teilnahme an der Veranstaltung kennen die Studierenden… • die grundlegende Aufgabenstellung der Regelungstechnik sowie den Unterschied zwischen Steuerung und Regelung • die Grundbegriffe und Werkzeuge zur Beschreibung und Analyse von dynamischen Systemen sowie deren Vor- und Nachteile • verschiedene Verfahren zur Prüfung der Stabilität eines Systems • unterschiedliche Methoden des Reglerentwurfs für lineare Systeme Fertigkeiten und Kompetenzen: Nach erfolgreicher Teilnahme an der Veranstaltung sind die Studierenden in der Lage... • für ein gegebenes technisches System ein für regelungstechnische Zwecke geeignetes dynamisches Modell zu formulieren • Lineare Systeme in diversen Beschreibungsformen zu analysieren und zu bewerten • zwischen den Beschreibungsformen für lineare Systeme geeignet zu wechseln und begründet die Form auszuwählen, die für die verfolgten Ziele am geeignetsten ist. • die Stabilität eines Systems zu ermitteln • anhand vorgegebener Kriterien den Entwurf eines Reglers selbständig durchzuführen
(Study-Specific) Prerequisites	Empfohlen: - Höhere Mathematik - Grundlegende Physikkenntnisse insb. der Mechanik,

	Elektrotechnik und Thermodynamik
(recommended) Requirements	Empfohlene Voraussetzungen (z.B. andere Module, Fremdsprachenkenntnisse, …): • Höhere Mathematik • Grundlegende Physikkenntnisse insb. der Mechanik, Elektrotechnik und Thermodynamik
References	H. Vallery: Regelungstechnik (Umdruck zur Vorlesung)
Language	German
Examination Terms	Eine schriftliche Klausur
Miscellaneous	-
Module coordinator	Univ.-Prof. Dr.-Ing. Heike Vallery
ECTS Credits	7
Contact time (WSH)	5
Examination duration (min)	-
Total hours (h)	210,0
Contact hours (h)	75,0
Self-study hours (h)	135,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Automatic Control (401255501)	5th semester	no semester recommended	7	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Automatic Control	5th semester	no semester recommended	-	2
Lecture Automatic Control	5th semester	no semester recommended	-	3
Treffpunkt Regelungstechnik	5th semester	no semester recommended	-	0

Module titel	Business Engineering (Compulsory elective subject)
Identifier	4011016
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2009
Valid until	-
Module level	Bachelor/Master
Content	1. Business management & change I 2. Business management & change II 3. Corporate governance 4. Process management I 5. Process management II 6. Controlling & financial management I 7. Controlling & financial management II 8. Controlling & financial management III 9. Investment appraisal and cost effectiveness analysis 10. Innovation management 11. Finance I 12. Finance II 13. Marketing I 14. Marketing II 15. (optional) Technology Management
Learning Objectives/ Learning Outcomes	• The students get used to the fundamentals of management in producing com-panies. • They realise the basic requirements about the different management areas and know the theories, models and methods. • They are in the position to scrutinise the learned possibilities critically and transfer them to real existing problems. • They obtain therewith the basic hand tool that is essential for the use in all management sections of producing companies.
(Study-Specific) Prerequisites	-
(recommended) Requirements	-
References	-
Language	German
Examination Terms	Notes chart / Ranking
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr.-Ing. Dipl.-Wirt. Ing. Günther Schuh
ECTS Credits	3
Contact time (WSH)	3
Examination duration (min)	-

Total hours (h)	90,0
Contact hours (h)	45,0
Self-study hours (h)	45,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Business Engineering (401101601)	6th semester	no semester recommended	3	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Business Engineering	6th semester	no semester recommended	-	1
Lecture Business Engineering	6th semester	no semester recommended	-	2

Module titel	Computer Assisted Surcical Technology (Compulsory elective subject)
Identifier	4013310
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Summer semester 2009
Valid until	-
Module level	Master
Content	1 <u>Einführung</u> • Einführung: Chirurgie und Chirurgietechnik • Historie, Aufgaben, Zielsetzung, 'minimal-invasive Chirurgie' • Arbeitsplatz Operationssaal 2 <u>chirurgische Instrumenten- und Gerätetechnik</u> • Anforderungen, Randbedingungen • Hygiene / Sterilisation • Technische Sicherheit 3-5 <u>Datenakquisition/Perzeption</u> • Bildgebungsverfahren (2-3D Fluoroskopie, CT, MR, Ultraschall, Endoskopie,...) kontextspezifische Charakteristika, Verfahren, Einbindung in den intraoperativen Arbeitsablauf, Anwendungsgebiete • intraoperative Messtechnik (3D-Lage- und Kraftsensorik), 'Smart Instruments' • Weitere Daten-/Informationsquellen (Atlanten, Modelle, Implantatdatenbanken, statistische Modelle) 6-8 <u>Bild-/Informationsverarbeitung und -Kombination</u> • Signal- und Bildanalysetechnik, Segmentierung • Grundlagen der Referenzierung • Extrinsische und intrinsische Registrierung (prä- und intraoperativ) • multimodale Referenzierungsverfahren (PTP, ICP, starr/elastisch, Morphing) • dynamische Referenzierung, medizinische und technische Limitierungen und Trends 9 <u>Chirurgische Planungs- und Simulationssysteme</u> • prä- vs. intraoperative Planungssysteme: Grundlagen und Anwendungen (Orthopädie und Unfallchirurgie, Dental- und kraniofaziale Chirurgie, Neuro- und Strahlentherapie) • Modellgestützte rechnerbasierte Planung • Fertigung und Anwendung physikalischer Planungsmodelle • computerassistierte Planung und Fertigung individueller Implantate und Vorrichtungen (CASP/CAM) 10-11 <u>Passive intraoperative Führungssysteme</u> • Stereotaxie • bildbasierte und bildlose Navigation • Mensch-Maschine-Interaktion (Augmented Reality, HAK, Benutzerschnittstellengestaltung, Usability/Limitierungen) • Planungsbasierte Leistungsregelung (Navigated Control) • Individualschablonen 12-13 <u>Semiaktive, synergistische und aktive Chirurgie-Robotik</u> • Systeme und Sicherheitskonzepte chirurgischer Robotersysteme; Bauformen, Kinematik • semiaktive Robotik mit passiver mechanischer Instrumentenführung • teilautomatisierte handgeführte Instrumente • synergistische planungsgesteuerte haptische Führungssysteme • Aktive Robotersysteme • Anwendungen: Roboter in Orthopädie, Neurochirurgie und Strahlentherapie

	• Entwicklungen, Trends 14 Chirurgische (Tele-)Manipulatoren • Anforderungen und Anwendungsszenarien (Minimal-Invasive Chirurgie, Interventionelle Radiologie...) • Bauformen, Kinematik, Systeme • Anwendungen, spezifische technische Ausführungsformen • Herausforderungen, Limits, Trends 15 Integrierte OP-Systeme • Anforderungen der Integration • Stand der Technik integrierter OP-Systeme • Offene Vernetzung,und IOT • ISO IEEE 11073 SDC • Erweiterte Funktionalität und Risikomanagement offen vernetzter Systeme
Learning Objectives/ Learning Outcomes	Nach erfolgreicher Teilnahme an den Modulveranstaltungen haben die Studierenden Kenntnisse und Fähigkeiten in den Themenfeldern, die unter Inhalt beschrieben werden, erworben. Wissen und Verstehen: Somit kennen die Studierenden insbesondere • Grundlagen, Entwicklung und Trends der computerunterstützten Chirurgie • Besonderheiten der Anwendung von technischen Anlagen im medizinischen Kontext • Grundlegende technologische Komponenten und Verfahrensschritte der Medizintechnik • Die für die computerunterstütze Chirurgie zum Einsatz kommenden multimodalen Datenquellen und Aufnahmeverfahren • Grundlegende Verfahren zur Extraktion und Kombination multimodaler Informationen auf Basis von Signal- und Bildanalyseverfahren sowie Referenzierungsverfahren • Grundlagen und Techniken der computergestützten Planung und rechnergestützen Fertigung von physikalischen Individualplanungsmodellen • Komponenten und Verfahren der intraoperativen Referenzierung und Navigation sowie deren theoretische Grundlagen, Charakteristika und Limitierungen • Ausführungsformen, Charakteristika und Anwendungen von Roboter- und Manipulatorsystemen in der Chirurgie Die Studierenden sind in der Lage, die Funktionsweise der bekannten Systeme zu erläutern und die Teilschritte der bekannten Verfahren zu benennen. Sie sind in der Lage, die wichtigen grundlegenden Charakteristika und Limitierungen der Datenquellen und Aufnahmeverfahren in der computerunterstützen Chirurgie zu erläutern. Fertigkeiten und Kompetenzen: In praktischen Übungen können die Studierenden erlerntes Wissen u.a. zu Mathematik, Messtechnik, Bildverarbeitung, Mechanik und Programmierung an Beispielen auf Basis einer selbständigen (angeleiteten) Problemanalyse praktisch experimentell erproben.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Empfohlene Voraussetzungen (z.B. andere Module, Fremdsprachenkenntnisse, …) • Medizintechnik I • Einführung in die Medizin (Baumann) • Physik und Mathematik • Grundvorlesungen Maschinenbau
References	(Präsenzbibliothek am Lehrstuhl einsehbar): • Konermann W. et al.: Navigation und Robotik in der Gelenk- und Wirbelsäulenchirurgie. Springer Verlag 2003 • Stiehl, Konermann, Haaker: Navigation and MIS in Orthopedic Surgery. Springer Verlag Berlin, 2007 • W. Niederlag, H.U.Lemke: Modellgestützte Therapie, Health Academy, 2008 • W. Niederlag, H.U.Lemke, G. Strauss, H. Feussner: Der Digitale Operationssaal. 2. Auflage, De Gruyter Verlag 2014

	• Kramme, R.: Medizintechnik. Verfahren, Systeme und Informationssysteme, 2. Aufl., Springer Verlag 2002 • Taylor, R.H.: Computer Integrated Surgery - Technology and Clinical Applications. MIT Press, Cambridge, MA, 1996 • Fedtke St. et al.: Computerunterstützte Chirurgie. Vieweg Verlag, 1994 • Peters, Terry; Cleary, Kevin (Eds.): Image Guided Interventions – Technology and Applications. Springer Verlag, 2008 • Umdruck/Foliensammlung zur Vorlesung Zeitschriften (Beispiele): • Journal of Computer Aided Surgery (Taylor&Francis) • Journal of Medical Robotics and Computer Assisted Surgery (Wiley) • (zahlreiche weitere Zeitschriften zu Teilaspekten; besonders geeignete Artikel werden als Kopien in der Vorlesungen/Übung nach Bedarf bereitgestellt) Konferenzen (K.-bände mit ISBN; K. teilw. mit Studierendenwettbewerb): • Computer Assisted Radiology and Surgery (CARS) • Medical Computing and Computer Assisted Interventions (MICCAI) • Computer Assisted Orthopaedic Surgery (CAOS) • Computer und Roboter Assistierte Chirurgie (CURAC)
Language	German
Examination Terms	Eine mündliche Prüfung
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr.-Ing. Klaus M. Radermacher
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	-
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Computer Assisted Surcical Technology (401331001)	4th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture/Laboratory Computer Assisted Surcical Technology	4th semester	no semester recommended	-	4

Module titel	Introduction to Mechanical Engineering (Compulsory elective subject)
Identifier	4010829
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2007
Valid until	-
Module level	Bachelor
Content	Energietechnik (Prof. Pischinger): •Erläuterung von Motivatoren in der Energietechnik (Weltenergiebedarf, Endlichkeit bestimmter Resourcen, Klimaschutz), Vorstellung verschiedener Bereiche der Energietechnik anhand von Beispielen •Detailliertes Bsp. "Verbrennungsmotor": 4-Takt-Verfahren, Wesensunterschied Diesel- und Ottomotor, Verknüpfung von Drehmoment, Leistung, Wirkungsgrad und Brennstoffenergie, Entwicklungsschwerpunkte beim Ottomotor, Downsizing, Vollständige Verbrennung, Zusammenhang Kraftstoffart/-verbrauch und CO2-Emissionen Verkehrstechnik: •Fahrzeugtechnik (Prof. Eckstein): Einflüsse auf Entwicklungsziele der Fahrzeugtechnik (Energiekosten, Mobilitätssteigerung, Klimaschutz) •Erläuterung des Entwicklungsziels "Verbrauchreduktion" an konkretem Versuchsträger: Leichtbau, Fahrwiderstandsreduzierung, Motordownsizing, regeneratives Bremsen •Vorstellung/Definition/Unterteilung/Bewertung Hybridtechnologie •Schienenfahrzeugtechnik (Prof. Schindler): Grundlagen der Neigetechnik: Zentrifugal-/ Zentripetalkraft, Wirkweise von Regelkreisen •Konkrete Ausführungen von Neigetechniksystemen: Unterscheidung zwischen aktiven und passiven Systemen Konstruktionstechnik (Prof. Jacobs): •Vorstellung der Konstruktion als branchenübergreifende Kerndisziplin des Maschinenbaus, Klassifikation technischer Systeme nach ihren Hauptflüssen (Materie, Energie, Signal)Am Bsp. Fahrrad werden verschiedene Disziplinen (Mechanik, Werkstoffkunde, Maschinengest., Antriebstechnik, Maschinen-,Strukturdynamik) der Konstruktion vorgestellt und mit unterstützenden Rechnersystemen in Verbindung gebracht Kunststofftechnik (Prof. Hopmann): •Vorstellung der Kunststoffe als vielseitig einsetzbare Werkstoffe, anhand von Anwendungsbsp. •Aufbau und Eigenschaften von faserverstärkten Kunststoffen •Teileherstellung aus Polymergranulat mittels Spritzgießen, rheologische, thermische, mechanische Werkzeugauslegung, Anwendungsbeispiel PET-Flasche, Innenbeschichtungen von Lebensmittelverpackungen Luftfahrttechnik (Prof. Stumpf): •Entwicklungstendenzen der Luftfahrttechnik •Beiwerte (cW-Wert, cA-Wert), Symmetrischer Gleitflug, Start und Landung von Verkehrsflugzeugen, Reichweite von Verkehrsflugzeugen Produktionstechnik (Prof. Brecher): •Kernkompetenzen und Aufgaben des Produktionstechnikers •Fertigungsverfahren (Urformen, Umformen, Zerspanen), Werkzeugmaschinen, Produktionsmanagement, Fertigungsmesstechnik, Produktionstechnik für Mikrosysteme, Werkstofftechnik, Darstellung von Fertigungsketten anhand von Beispielen (Getriebewelle, Turbinenschaufel) Textiltechnik (Prof. Gries): •Anwendungsgebiete, Herstellungsverfahren, Rohstoffe, Darstellung der Prozesskette anhand von Bsp.(Jeans, Automobilkomponenten, Implantate) Verfahrenstechnik (Prof. Mitsos): •Herstellung regenerativer Energieträger, Vergleich verschiedener Verfahren mit solarem Wirkungsgrad von Photovoltaik (Biodiesel, Biomass to Liquid, Photofermentation), Verwendung von Membranen zur Stofftrennung (Oxycoal-AC, Trinkwassererzeugung),

	Trennung von Emulsionen mit Abscheidern, Absetzverhalten, Tropfen-Tropfenkoaleszenz, Kräftebilanz am einzelnen Tropfen
Learning Objectives/ Learning Outcomes	Fachbezogen: • Die Studierenden sind in der Lage erste, wenn auch grobe Sachverhalte aus den verschiedenen Fachrichtungen des Maschinenbaus darzustellen. Nicht fachbezogen (z.B. Teamarbeit, Präsentation, Projektmanagement etc.): • Die Studierenden erkennen die Wichtigkeit der theoretischen Grundlagen für die spätere Praxis in ingenieurswissenschaftlichen Berufsfeldern. • Sie ordnen die vorgestellten Fachrichtungen nach persönlichem Interesse.
(Study-Specific) Prerequisites	-
(recommended) Requirements	-
References	• Vorlesungsfolien werden als Begleitmaterial zu den Veranstaltungen ausgeteilt • Sowohl Vorlesungsfolien als auch Übungsaufgaben stehen im zugehörigen Lernraum online zur Verfügung
Language	German
Examination Terms	Eine schriftliche Klausur
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr.-Ing. (USA) Stefan Pischinger Universitätsprofessor Dr.-Ing. Christian Hopmann Universitätsprofessor Dr.-Ing. Lutz Eckstein Universitätsprofessor h. c. (MGU) Dr.-Ing. Dipl.-Wirt. Ing. Thomas Gries Universitätsprofessor Dr.-Ing. Georg Jacobs Universitätsprofessor Dr.-Ing. Dieter Moormann Universitätsprofessor Dr.-Ing. Christian Schindler Universitätsprofessor Dr.-Ing. Matthias Weßling Universitätsprofessor Dr.-Ing. Andreas Jupke Universitätsprofessor Dr.-Ing. Thomas Bergs
ECTS Credits	1
Contact time (WSH)	2
Examination duration (min)	-
Total hours (h)	30,0
Contact hours (h)	30,0
Self-study hours (h)	,0

+ Introduction to Mechanical Engineering (4010829)

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Introduction to Mechanical Engineering (401082901)	4th semester	no semester recommended	1	0

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture/ Exercise Introduction to Mechanical Engineering	4th semester	no semester recommended	-	2

Module titel	Electromechanic Motion Technology (Compulsory elective subject)
Identifier	4013311
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Summer semester 2010
Valid until	-
Module level	Bachelor/Master
Content	1 • Einführung • Grundlegende Zusammenhänge • Anwendungsgebiete 2 • Beuformen von Getrieben: Getriebearten nach Hauptbaulementen, Getriebearten nach Funktion 3 • Kurbelgetriebe • Grundlagen und Anwendungen • Graphische Lageanalyse • Rechnerische Lageanalyse 4 • Kurbelgetriebe • Graphische Lagesynthese 5 • Kurbelgetriebe • Rechnerische Lagesynthese • Totlagensynthese 6 • Kurbelgetriebe • Geschwindigkeiten (rein graphische Verfahren) 7 • Kurbelgetriebe • Geschwindigkeiten (Euler/Satz der Relativgeschwindigkeit) 8 • Kurbelgetriebe • Beschleunigungen (Euler) 9 • Kurvengetriebe • Beschleunigungen (Satz der Relativbeschleunigungen) 10 • Kurvengetriebe • Grundlagen und Anwendungen • Bewegungsaufgabe und Übergangsfunktion • Kinematische Hauptabmessungen 11 • Kurvengetriebe • Hodographenverfahren

	• Verfahren nach Flocke • Führungs- und Arbeitskurve 12 • Elektrische Drehantriebe • Elektrische Linearantriebe 13 • Motormodelle • Regelung von elektrischen Antrieben 14 • Anwendungsbeispiel • Prinzipsynthese • Maßsynthese • Auslegung
Learning Objectives/ Learning Outcomes	Fachbezogene Lernziele: • Die Studierenden haben ein tiefes Verständnis über die Grundlagen sowie Auslegung und Berechnung von elektromechanischen Antriebssystemen. • Die Studierenden sind in der Lage eine Bewegungsaufgabe zu erfassen, zu beschreiben und in einer Anforderungsliste an die Bewegungseinrichtung zusammenzufassen. • Die Studierenden kennen die wichtigsten Merkmale der verschiedenen elektrischen Antriebe und sind in der Lage, die für die jeweilige Antriebsaufgabe optimalen Antriebe auszuwählen. • Die Studierenden sind fähig, nach Antriebsauswahl mit Hilfe verfügbarer Katalogdaten die entsprechenden Berechnungen durchzuführen. • Die Studierenden kennen die wesentlichen Unterschiede und Einsatzarten von Kurbel- und Kurvengetrieben. Dabei sind sie in der Lage, die jeweils wesentlichen Einflussfaktoren aufzugliedern und hieraus geeignete Verfahren zur Getriebeauswahl anzuwenden. • Für die zu analysierenden Maschinen und Mechanismen leiten die Studierenden aus ihren gewonnenen Kenntnissen die erforderlichen Methoden und Verfahren zur Synthese und Analyse her. Sie sind damit in der Lage, mit ihrem erworbenen theoretischen Hintergrund, umfassende Fragestellungen und Probleme zur Auswahl und Auslegung von Bewegungseinrichtungen aus der Industrie zu beantworten und zu lösen. Nicht fachbezogene Lernziele (z.8. Teamarbeit, Präsentation, Projektmanagement, etc.) • keine
(Study-Specific) Prerequisites	-
(recommended) Requirements	Empfohlene Voraussetzungen: • Mechanik I,II,III • Mathematik I bis III und numerische Mathematik
References	• Kerle, H.; Corves, B.; Hüsing, M.: Einführung in die Getriebelehre. Stuttgart Leipzig Wiesbaden: B.G. Teubner Verlag, 2011. • Luck, K.; Modler, K.-H..: Getriebetechnik: Analyse, Synthese, Optimierung. Berlin Heidelberg New York: Springer-Verlag, 1995.
Language	German
Examination Terms	Klausurformat: Eine schriftliche Klausur oder eine mündliche Prüfung. Endnote Die Endnote ergibt sich aus der Note der Klausur bzw. aus der Note der mündlichen Prüfung, falls ausschließlich mündliche Prüfungen stattfinden. Informationen zur Bonuspunkte-Regelung: Für das Fach Elektromechanische Antriebstechnik werden zur Förderung des Selbststudiums semesterbegleitend Freiwillige Zusatzaufgaben angeboten. In sechs solcher selbstständig zu bearbeitenden Zusatzaufgaben können bei entsprechender Benotung bis zu 5% der in der schriftlichen Klausur erzielbaren Punkte angesammelt werden, die im Falle einer schriftlichen Klausur zu einer Verbesserung der Klausurnote führen können. Die Notenverteilung wird ausschließlich anhand der Ergebnisse aus der regulären Klausur festgelegt. Aus der Summe der Klausur- und Bonuspunkte ergibt sich nach der zuvor festgelegten Notenverteilung die

	Endnote. Durch die Bonuspunkte kann nur die Note einer bestandenen Klausur verbessert werden, eine Notenverbesserung von der Note 5,0 auf die Note 4,0 ist nicht möglich. Für den Fall, dass im Semester eine mündliche Prüfung angeboten wird, werden die Bonuspunkte nicht Berücksichtigt. Auch ohne Bearbeitung der Zusatzaufgaben können 100% der Klausurpunkte erreicht werden, als auch eine Endnote von 1.0 für das Modul selbst. Umfang der Zusatzaufgaben: Bei den Zusatzaufgaben handelt es sich um sechs selbstständig durchgeführte, digitale Prüfungen zu den in der Veranstaltung behandelten Themenblöcken. Die jeweiligen Termine und Zeiträume zur Durchführung, sowie die verwendete Prüfungssoftware werden zu Semesterbeginn im Lernraum bekanntgegeben. Benotung der Zusatzaufgaben: Für jeden der sechs Zusatzprüfungen kann bis zu 1 Bonuspunkt vergeben werden. Die Vergabe von Bonuspunkten erfolgt nach dem erreichten Anteil der maximal erreichbaren Punkte je Test. Wurden in einem Test mindestens 75% der maximal erreichbaren Punkte erzielt wird 1 Bonuspunkt für die Klausur vergeben. Wurden in einem Test mindestens 50%, aber weniger als 75% der maximal erreichbaren Punkte erzielt werden 0,5 Bonuspunkte für die Klausur vergeben. Gültigkeitsdauer der Bonuspunkte: Die Bonuspunkte gelten für alle schriftlichen Prüfungen im Fach Elektromechanische Antriebstechnik im Semester in dem diese erzielt wurden, als auch in dem direkt folgenden Semester. Danach müssen die Bonuspunkte durch die erneuten Bearbeitung der Zusatzaufgaben neu verdient werden.
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr.-Ing. Dr. h. c. Burkhard Corves
ECTS Credits	5
Contact time (WSH)	4
Examination duration (min)	-
Total hours (h)	150,0
Contact hours (h)	60,0
Self-study hours (h)	90,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam or Oral Exam Electromechanic Motion Technology (401331101)	4th semester	no semester recommended	5	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Electromechanic Motion Technology	4th semester	no semester recommended	-	2

Exercise Electromechanic Motion Technology	4th semester	no semester recommended	-	2

Module titel	Energy Economy (Compulsory elective subject)
Identifier	4011028
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Summer semester 2009
Valid until	-
Module level	Bachelor/Master
Content	• Steigende Energiepreise und notwendige Minderungen der C02-Emissionen erfordern einen effizienten Einsatz aller zur Verfügung stehenden Energieträger. Der Wirtschaftlichkeit von Investitionen im Energiemarkt muss dabei besondere Aufmerksamkeit geschenkt werden. • Die ökonomische Bewertung des Einsatzes neuer und vorhandener Erzeugertechnologien ist daher ein Schwerpunkt der Veranstaltung. Im weiteren Verlauf werden die Mechanismen des nationalen und internationalen Strom-, Wärme- und Gasmarkts behandelt und die Optimierungsmethodik sowie die Regulierungsmethoden des Staats vorgestellt. • Energiekennzahlen: Zusammenhänge in der Energiewirtschaft, Globale Energiewirtschaft, Energiekennzahlen • Wirtschaftlichkeitsanalyse: Grundbegriffe der Investition und Finanzierung, Kennzahlen der Wirtschaftlichkeit, statische und dynamische Verfahren • Investition und Risiko: Risikobetrachtung- und berechnung von Investitionen • Modelle für Erzeuger: Techniken, Wirtschaftliche und technische Kennzahlen • Verbrauchermodelle und Speichertechniken: Bedarfsermittlung, Jahresdauerlinie • Speichertechniken Energiemärkte - Strommarkt: Teilnehmer des Marktes, Arten von Strommärkten , Strom gesteh ungskosten, Emissionshandel • Energiemärkte - Gas- und Wärmemarkt: Zukunftspotentiale dieser Märkte, Unterschiede zum Strommarkt, Nah- und Fernwärmenetze • Optimierung: Aufbau von Optimierungsproblemen, Lösungsverfahren (z.B. grafische, • Simplex, Branch-and-Bound}, Aufstellen und Lösen von Mixed Integer Linear Problems (MILP} • Regulierung: Einflussmöglichkeiten des Gesetzgebers, Umsetzungsbeispiele der • Einflussmöglichkeiten aus Vergangenheit und Gegenwart
Learning Objectives/ Learning Outcomes	Wissen und Verstehen: • Die Energiewirtschaft wird im Konftiktfeld zwischen Mensch, Umwelt, und Wirtschaftlichkeit betrachtet. Die Studierenden erlernen die Grundlagen der Wirtschaftlichkeitsberechnung und deren Kennzahlen mit Bezug zur Energiewirtschaft. Hierbei werden aktuelle Vorgänge am Strom-, Gas- und Wärmemärkte sowie der Regulierung durch den Staat vermittelt. Die Studierenden verstehen, wie Modelle für konventionelle und regenerative Strom- und Wärmeerzeuger und -verbraucher aufgebaut sind und lernen die Optimierung als Methode im Rahmen der Energiewirtschaft kennen. Die Betrachtung des Risikos in Investitionsentscheidungsprozessen wird mithilfe von Szenarienentwicklungen vermittelt. Fertigkeiten und Kompetenzen: • Die Studierenden können unter Anwendung verschiedener Verfahren der Investitionsrechnung die Investition in energietechnische Anlagen mithilfe von wirtschaftlichen Kennzahlen einschätzen und Investitionsentscheidungen treffen. Hierzu können sie Bedarfe von Verbrauchern berechnen und unter wirtschaftlichen, technischen und • ökologischen Randbedingungen diverse Wärme- und Stromversorgungsanlagen bewerten. Die Studierenden können das Risiko der Investitionen mithilfe von Szenarienentwicklung berechnen und einschätzen. Diese Szenarien können von den

	Studierenden in Modelle überführt werden. Des Weiteren können die Studierenden Optimierungsprobleme vor dem Hintergrund energiewirtschaftlicher Fragestellungen mittels verschiedener Verfahren aufstellen und lösen.
(Study-Specific) Prerequisites	-
(recommended) Requirements	keine
References	• Vorlesungsskript
Language	German
Examination Terms	• Eine schriftliche Prüfung • Es können Bonuspunkte für Hausaufgaben gegeben werden. Diese werden bei Durchführung in der Vorlesung vorgestellt. Die maximal erreichbare Punktzahl in der Bonuspunkteaufgabe soll 10 % der in der Klausur erreichbaren max. Punktzahl entsprechen.
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr.-Ing. Dirk Müller
ECTS Credits	4
Contact time (WSH)	3
Examination duration (min)	-
Total hours (h)	120,0
Contact hours (h)	45,0
Self-study hours (h)	75,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Energy Economy (401102801)	6th semester	no semester recommended	4	0

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Energy Economy	6th semester	no semester recommended	-	2
Exercise Energy Economy	6th semester	no semester recommended	-	1

Module titel	Factory Design (Compulsory elective subject)
Identifier	4014335
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Summer semester 2009
Valid until	-
Module level	Bachelor/Master
Content	1 Introduction to Factory Planning & Project Management 2 Target Definition & Product/ Process Planning 3 Location Planning & Factory Structure Planning 4 Industrial Building & Building Planning 5 Production Structure Planning & Capacity Planning 6 Layout Planning & Workplace Design
Learning Objectives/ Learning Outcomes	The students are able to describe the characteristics and challenges of factory planning and with regard to the global environment. They can formulate the object precisely and detailed as well as the procedures and methods in factory planning. Based this comprehension the students have the competence to analyse the initial situation and to draft and classify possible solutions. Thus, the students are able to apply the acquired methods to holistically design a factory.
(Study-Specific) Prerequisites	-
(recommended) Requirements	keine
References	Vorlesungsumdruck
Language	German
Examination Terms	Ranking In the module 'Factory Planning', bonus points for the exam can be achieved. Within 6 single exercises (e-tests in the L²P), up to 0.5 points per test can be awarded (min. 50% correct answers). Overall, 3.0 bonus points or 2.5% of the total number of points can be gained for the exam. An improvement from grade 5.0 to grade 4.0 is not possible. All reached bonus points are also valid for the respective winter term.
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr.-Ing. Dipl.-Wirt. Ing. Günther Schuh
ECTS Credits	2
Contact time (WSH)	2
Examination duration (min)	-
Total hours (h)	60,0
Contact hours (h)	30,0

Self-study hours (h)	30,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Factory Design (401433501)	6th semester	no semester recommended	2	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Factory Design	6th semester	no semester recommended	-	1
Exercise Factory Design	6th semester	no semester recommended	-	1

Module titel	Communication and Organisation Development (Compulsory elective subject)
Identifier	4010971
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2007
Valid until	-
Module level	Bachelor/Master
Content	1. Introduction to COD 2. History of organisational development 3. Organisational structures 4. Organisations as open cybernetic systems 5. monologual communication 6. dialogual communication 7. Tools of operational communication (Part I) 8. Tools of operational communication (Part II) 9. Methods of change management (Part I) 10. Methods of change management (Part II) 11. Systemic organisation development 12. Organisational diagnosis 13. Redesign of organisations 14. Organisation development in networks 15. Communication in networks
Learning Objectives/ Learning Outcomes	With respect to the subject: • Students are introduced to the most common communication models and will be enabled to apply those to implementable examples in companies. • They are in the position to identify and explain organisational structures and will be able to draw conclusions about working and communication processes. • Students will learn to recognise means of analysis and scope concerning communication and organisation processes and are enabled to exemplify and apply relevant tools. • Actual developments in the field of communication and organisation development (COD) are to be classified refering to different streams and the historical background of COD. Practical qualitative and quantitative observations within the field of COD will be reflected and correlated by the students. • The systemic understanding of organisations and their communication processes has been further developed: Real situations within organisations can be judged and well founded decision making proposals can be made. • Students will understand COD processes as complex procedures and are in the position to apply tools for the systemic diagnosis and for the redesign of organisations. Not with respect to the subject (e.g. Team work, Presentation, Project Management, etc.): • Development and supervision of efficient working in teams • Implementation of communication media in teams • Implementation of methods of project management for the analysis of an organisation (laboratory exercise)
(Study-Specific) Prerequisites	-
(recommended) Requirements	-

References	• Kommunikations- und Organisationsentwicklung, Vorlesungsdruck, 6. überarbeitete Auflage 2000.
Language	German
Examination Terms	Eine schriftliche Klausur. Im Rahmen des Labors soll es den Studierenden möglich sein bis zu 33 Punkte bzw. 10 % zur Hauptprüfung als Bonuspunkte zu erhalten. Die Gruppenarbeit besteht aus folgenden Kriterien: • Abgabe je eines Konzepts (max. 10 Seiten) • Einreichung eines Produktvideos (Länge: 3 Minuten) • Vorlage einer Liste mit allen beteiligten Studierenden (Identifikation über Matrikelnummer) zum Abschluss der Unternehmenssimulation. Es ist auch ohne diese Bonuspunkte möglich, die bestmögliche Note zu erreichen. Erlangte Bonuspunkte haben keinen Einfluss auf das Prüfungsergebnis, wenn dieses „nicht bestanden“ (5,0) lautet.
Miscellaneous	-
Module coordinator	apl. Professorin Dr. phil. Ingrid Isenhardt
ECTS Credits	3
Contact time (WSH)	3
Examination duration (min)	-
Total hours (h)	90,0
Contact hours (h)	45,0
Self-study hours (h)	45,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Communication and Organisation Development (401097101)	4th semester	no semester recommended	3	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Laboratory Communication and Organisation Development	4th semester	no semester recommended	-	2
Lecture Communication and Organisation Development	4th semester	no semester recommended	-	1

Module titel	Aircraft Systems (Compulsory elective subject)
Identifier	4011046
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Summer semester 2009
Valid until	-
Module level	Bachelor/Master
Content	Vorlesung 1 - Luftverkehr • Definition des Systembegriffes • Im Wettbewerb zum Luftverkehr stehende Transportwege • Das Produkt Flugreise • Luftfrachtmarkt Vorlesung 2 - Luftrecht • Abkommen und Organisationen • Zulassungvorschriften Vorlesung 3 - Sicherheit • Begriffsdefinitionen im Rahmen der Sicherheit • UnfallstatistikenInstitutionen und Überprüfungen Vorlesung 4 - Fluggerät in Theorie und Anwendung • Historische Entwicklung • Massenverteilung • Atmosphäre und Geschwindigkeiten • Flugphysik • Triebwerke Vorlesung 5 - Missionsanalyse • Missionsarten • Missionsziele für Fracht- und Passagierverkehr • Optimierungsparameter • Wegpunkte und Flightmanagement Vorlesung 6 - Hersteller • Bedarfsanalyse • Produktpolitik • Struktur der zivilen Luftfahrtindustrie • Projektphasen eines Flugzeuglebens • Kostenmanagemen Vorlesung 7 - Airlines • Ziviler Passagiermarkt • Strategien • Kostenmanagement • Aufgaben einer Airline Vorlesung 8 - Maintenance • Marktzusammensetzung • Triebwerkswartung und deren Geschäftsmodelle • Regionale Unterschiede Vorlesung 9 - Flughafenarchitektur • Systemüberblick eines Flughafens • Kategorien und Kunden • Wettbewerb

	Vorlesung 10 - Flughafenlogistik • Interaktion zwischen Flugzeugen und Flughäfen • Turnaround Zubringer- und Passagierlogistik Vorlesung 11 - An- und Abflug • An- und Abflugprozeduren • Warteschleifen • Innovative Flugführung Vorlesung 12 - Flugsicherung • Bsp. Deutschland • Luftraumunterteilung vertikal Internationaler Luftraum Vorlesung 13 - Umwelt • Abgasemissionen • Fluglärm • Lärmminderung Vorlesung 14 - Zukunftsaspekte • Alternative Kraftstoffe • Alternative Antriebe • Innovative Technologien • Entwicklung des Personenverkehrs Vorlesung 15 • Zusammenfassung • Prüfungsvorbereitung
Learning Objectives/ Learning Outcomes	Fachbezogene Lernziele • Der Student kennt die wichtigen Einflüsse denen das System Luftverkehr unterliegt und das Zusammenspiel der beteiligten Gruppen. • Die hieraus auf die Technologie des Flugzeugs und Luftverkehrssystem erwachsenden Anforderungen sind ihm bewusst und kann diese markwirtschaftlichen, ökologischen oder soziologischen Quellen zuordnen. • Er kennt derzeitige Lösungsansätze für aktuelle Problemstellungen.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Empfohlene Voraussetzungen (z.B. andere Module, Fremdsprachenkenntnisse, …): • Grundlegende Englischkenntnisse
References	Vorlesungsumdruck Unterlagen im L2P-Lernraum
Language	German
Examination Terms	Die Endnote ergibt sich aus der Note der mündlichen Prüfung.
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. Ing. Eike Stumpf
ECTS Credits	3
Contact time (WSH)	2
Examination duration (min)	-
Total hours (h)	90,0
Contact hours (h)	30,0
Self-study hours (h)	60,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Aircraft Systems (401104601)	6th semester	no semester recommended	3	0

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Aircraft Systems	6th semester	no semester recommended	-	2

Module titel	Medical Engineering I (Compulsory elective subject)
Identifier	4013321
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2008
Valid until	-
Module level	Bachelor/Master
Content	1 • Einführung in die Medizintechnik • Entwicklung, Aufgabengebiete und Randbedingungen der Medizintechnik; Überblick zur Diagnose-, Therapietechnik 2-4 • Medizinische Bildgebung (I) • Grundlagen insbesondere der Röntgenbildgebung (inkl. CT), Magnet-Resonanztomographie und Ultraschallbildgebung (Weiterführung und Vertiefung zur Medizinischen Bildgebung in Medizintechnik II) • Darstellung von Materialien und Strukturen (Morphologie/ physikalische/mech. Eigenschaften,…,Funktion) im Bild • Berücksichtigung spezifischer Wechselwirkungen bei Materialauswahl und Gestaltung 5 • Biokompatibilität und Biofunktionalität • Definition und Bedeutung von Biokompatibilität und Biofunktionalität; Prüfverfahren; Gewebeeigenschaften; Reaktionen des menschlichen Organismus 6-8 • Biomechanik • Überblick und Grundlagen der Biomechanik, Bedeutung in der Diagnose und Therapietechnik • Biomechanik von Stütz- und Bewegungsapparat, Implantate, Endo- und Exoprothesen (ausgewählte Beispiele, Vertiefung in „Grundlagen der Biomechanik des Stütz- und Bewegungsapparates“ und „Medizintechnik II“) • Kurzer Überblick zur Biomechanik von Herz und Kreislauf, Atmung, Niere, Ersatz- und Unterstützungssysteme (Weiterführung und Vertiefung in „Physiologische und technische Grundlagen natürlicher und künstlicher Organe“) 9 • Hygiene und Hygienetechnik • Grundlagen der Hygiene; Verfahren und Wirkprinzipien der Desinfektion und Sterilisation; Komponenten und Bauweisen sterilisierbarer Instrumente und Geräte; Krankenhaushygiene 10-13 • Biomaterialien • Einführung und Überblick; mechanische Eigenschaften, Korrosionsbeständigkeit, Biokompatibilität und Hauptanwendungsgebiete metallischer Werkstoffe (einschl. FGL) • Herstellung und Verarbeitung, Sterilisation und Biokompatibilität, Eigenschaften und Anwendungen biokompatibler synthetischer Polymere • Degradationsmechanismen biodegradierbarer Polymere; Struktur und Eigenschaften, Gewinnung, Verarbeitung und Anwendung natürlicher Polymere • Herstellung, Eigenschaften und Anwendungen keramischer Werkstoffe und Faserverbundwerkstoffe in der Medizintechnik 14 • Ausgewählte Fertigungsverfahren für die Medizintechnik • Generative Fertigung von Individualimplantaten, Beschichtung von Implantaten, Herstellung von Zellträgersystemen

	15 • Medizinprodukterecht, Qualität und Sicherheit • Überblick, rechtliche Grundlagen, Konformitätsbewertungsverfahren, Qualitäts- u. Risikomanagement, Sicherheitskonzepte, Schutzmassnahmen und Sicherheit (Weiterführung und Vertiefung in „Ergonomie und Sicherheit von Medizinprodukten“)
Learning Objectives/ Learning Outcomes	Fachbezogen: • Die Studierenden verfügen über grundlegende Kenntnisse der Medizintechnik (Materialien, Bauweisen, Einsatz- und Randbedingungen,…) als Einführung insbesondere für den konstruktiven Bereich der Entwicklung von Instrumenten und Geräten oder auch Organersatz- und Unterstützungssystemen, und damit u.a. über eine Basis für weiterführende Veranstaltungen im Bereich/Schwerpunkt Medizintechnik. Sie sind in der Lage, unterschiedliche Anwendungsbereiche und -beispiele sowie spezifische Randbedingungen der Medizintechnik für Diagnose und Therapie zu nennen und zu erläutern. • Die Studierenden verfügen über Grundkenntnisse zu normativen Anforderungen bei der Zulassung von Medizinprodukten und deren Bedeutung für die Entwicklung. Sie können ihre Kenntnisse über die besonderen Randbedingungen und Sicherheitsanforderungen der Medizintechnik bei der Bewertung von medizintechnischen Lösungen anwenden. Die Studierenden kennen die wichtigsten Bildgebungsverfahren in der Medizin und können deren grundlegende physikalische Wirkprinzipien erklären. Diese Kenntnisse können sie bei der Auswahl von Materialien im Rahmen der Konstruktion von Komponenten und Systemen anwenden. Die Studierenden sind in der Lage, die Begriffe Biokompatibilität und Biofunktionalität und deren Bedeutung für medizintechnische Produkte zu erläutern und an Beispielen zu verdeutlichen. Sie kennen grundlegende Gewebeeigenschaften und Gewebereaktionen. Die Studierenden kennen die Bedeutung der Hygiene in der Medizintechnik, können Verfahren und Wirkprinzipien der Desinfektion erläutern und diese Kenntnisse bei der Entwicklung bzw. Bewertung von technischen Lösungen anwenden. Insbesondere verfügen sie über Kenntnisse zu geeigneten Konstruktionswerkstoffen und Gestaltungsprinzipien für unterschiedliche medizintechnische Anwendungen und können Besonderheiten hinsichtlich der Eigenschaften, Herstellung und Anwendung erläutern und bei der Lösungssynthese und –evaluation umsetzen. Die Studierenden verfügen über grundlegende Kenntnisse zu ausgewählten Fertigungsverfahren zur Herstellung von Individualimplantaten, zur Beschichtung von Implantaten sowie von Zellträgersystemen, können diese in Grundzügen erklären und bei der Auswahl bzw. Entwicklung konstruktiver Lösungen auf diese Kenntnisse zurückgreifen und bedarfsweise vertiefen.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Empfohlene Voraussetzungen (z.B. andere Module, Fremdsprachenkenntnisse, …) • Einführung in die Medizin (Baumann); (ggf. auch parallel) • Physik, Mathematik • Grundvorlesungen Maschinenbau (Semester 1-4: Mechanik, Werkstoffkunde, Maschinengestaltung, Elektrotechnik, Strömungsmechanik I, Messtechnik,…) Voraussetzung für (z.B. andere Module) • Medizintechnik II
References	1. • Hutten, H.: Biomedizinische Technik 1-4, Springer-Verlag 1992 2. • Wintermantel, E., Ha, S-W.: Medizintechnik mit biokompatiblen Werkstoffen und Verfahren. 3. • Aufl. Springer-Verlag 2002 3. Enderle, J., Blanchard, S., Bronzino, J.: Introduction to Biomedical Engineering. 2nd Edition, Elsevier Academic Press 2005 4. • B.D. Ratner, A.S. Hoffmann, F.J. Schoen, J. E. Lemons: Biomaterial Science. 2nd Edition, Elsevier 2004 5.

	• Kramme, R.: Medizintechnik. Verfahren, Systeme und Informationssysteme, 2. Aufl., Springer Verlag 2002 6. • St. Silbernagl, A. Despopoulos: Taschenatlas der Physiologie, 6. Aufl., Thieme-Verlag, 2003 7. • B. Kummer: Biomechanik. Deutscher Ärzteverlag, 2005 8. • Zeitschrift für Biomedizinische Technik (…zahlreiche weitere Bücher und Zeitschriften zu Teilaspekten; besonders geeignete Artikel werden als Kopien in der Vorlesungen/Übung nach Bedarf bereitgestellt) 9. • Umdruck/Foliensammlung zur Vorlesung
Language	German
Examination Terms	Eine Klausur
Miscellaneous	-
Module coordinator	Modulverantworlicher: Universitätsprofessor Dr.-Ing. Klaus M. Radermacher
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	120
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Medical Engineering I (401332101)	4th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Vorlesung/Übung Medizintechnik I	4th semester	no semester recommended	-	4

Module titel	Medical Engineering II (Compulsory elective subject)
Identifier	4014433
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Winter semester 2005
Valid until	-
Module level	Bachelor/Master
Content	1 • Einführung • Überblick zur Instrumenten- und Gerätetechnik • Überblick Krankenhaustechnik • Stellenwert, Entwicklungen und Trends 2-4 • Medizinische Bildgebung (II) • Überblick und Gegenüberstellung der wichtigsten medizinischen Bildgebungsverfahren (Röntgen, Computertomographie, MR-Tomographie, PET, SPECT, Ultraschall, Endoskopie, Mikroskopie, OCT,…; Eigenschaften, Anwendungsgebiete und Grenzen) • Aufbau, Bauformen und zugrundeliegenden Verfahren der Bilderfassung bzw. -rekonstruktion 5-6 • Biosignalerfassung, Funktionsdiagnostik und Monitoring • Übersicht zu den wichtigsten Verfahren zur Erfassung von Biosignalen und anderer Vitalparameter • Gerätesysteme für Funktionsdiagnostik und Monitoring (Wirkprinzipien, Eigenschaften, Anwendungsbereiche) 7 • Krankenhaus- und OP-Technik • Infrastruktur, Komponenten und Gerätesysteme • Informationsflüsse und –verarbeitung, Arbeitsabläufe • Übersicht zu Normen und Richtlinien 8 • Anästhesie und Intensivpflege • Überblick Narkose, Beatmung, Notfallmedizin • Gerätetechnik (Wirkprinzipien, Eigenschaften, Anwendungsbereiche) 9 • Laser in der Medizin • Medizinische Lasersysteme (Aufbau, Medien, Eigenschaften) • Biophysikalische Wirkung und Anwendungen • Gerätesysteme und Applikatoren • Sicherheitstechnische Aspekte und Normen 10 • Hochfrequenzchirurgie • Überblick und Entwicklung • Physikalische und technische Grundlagen • Monopolare und bipolare Technik • Sicherheitstechnische Aspekte und Normen 11 • Chirurgische Instrumente- und Gerätetechnik • Chirurgische Motorensysteme und Instrumente • Systeme und Komponenten für die endoskopische Chirurgie

	• Überblick dentaltechnische Instrumente • Überblick zur computerunterstützten Chirurgie 12 • Strahlentherapie • Physikalische und technische Grundlagen • Biophysikalische Wirkung und Anwendungen • Systeme und Komponenten • Sicherheitstechnische Aspekte 13 • Therapeutische Anwendung von Ultraschalll, Stoßwellentherapie • Physikalische und technische Grundlagen • Biophysikalische Wirkung und Anwendungen • Systeme und Bauweisen • Sicherheit 14 • Rehabilitationstechnik • Funktionelle Analyse • Funktionelle Stimulation • Künstliche Gliedmaßen • Rollstuhltechnik • Kommunikationshilfen 15 • Repetitorium
Learning Objectives/ Learning Outcomes	Fachbezogen: • Die Studierenden kennen und verstehen Aufbau, Theorie und Wirkungsweise wichtiger diagnostischer und therapeutischer Instrumente, Geräte und Systeme und eren Eigenschaften, Stellenwert und Anwendungsbereiche und können diese in Grundzügen erläutern • Sie können die wesentlichen Komponenten der Krankenhaus- und OP-Technik benennen und erklären und kennen die Bedeutung grundlegender Prozesse, Informationsflüsse und Arbeitsabläufe und können einzelne Komponenten einordnen • Sie kennen die wichtigsten Normen und Sicherheitsanforderungen für die jeweiligen Komponenten und Systeme bzw. können die jeweils aktuellen Bestimmungen ermitteln und anwenden Nicht fachbezogen (z.B. Teamarbeit, Präsentation, Projektmanagement, etc.): • Die Studierenden sind in der Lage selbständig ein Themengebiet aus vorgegebener interdisziplinärer Literatur aufzuarbeiten, diese durch eigene Recherchen zu ergänzen, und aus ingenieurwissenschaftlicher Sicht zu analysieren und zu bewerten. • Die Studierenden können sowohl interdisziplinäre wie auch ingenieurwissenschaftliche Aspekte des bearbeiteten Themengebietes in einer Präsentation zusammenfassend darstellen, erläutern und diskutieren. • In den Übungen erfolgt die Arbeit teilweise in Kleingruppen, so dass kollektive Lernprozesse gefördert werden (Teamarbeit)
(Study-Specific) Prerequisites	-
(recommended) Requirements	Empfohlene Voraussetzungen (z.B. andere Module, Fremdsprachenkenntnisse, …): • Medizintechnik I • Einführung in die Medizin (Baumann) • Physik, Mathematik • Grundvorlesungen Maschinenbau
References	• Hutten, H.: Biomedizinische Technik 1-4, Springer-Verlag 1992 • Wintermantel, E., Ha, S-W.: Medizintechnik mit biokompatiblen Werkstoffen und Verfahren. 3. Aufl. Springer-Verlag 2002 • Enderle, J., Blanchard, S., Bronzino, J.: Introduction to Biomedical Engineering. 2nd Edition, Elsevier Academic Press 2005 • B.D. Ratner, A.S. Hoffmann, F.J. Schoen, J. E. Lemons: Biomaterial Science. 2nd Edition, Elsevier 2004 • Kramme, R.: Medizintechnik. Verfahren, Systeme und Informationssysteme, 2. Aufl., Springer Verlag 2002

	• St. Silbernagl, A. Despopoulos: Taschenatlas der Physiologie, 6. Aufl., Thieme-Verlag, 2003 • B. Kummer: Biomechanik. Deutscher Ärzteverlag, 2005 • Zeitschrift für Biomedizinische Technik (…zahlreiche weitere Bücher und Zeitschriften zu Teilaspekten; besonders geeignete Artikel werden als Kopien in der Vorlesungen/Übung nach Bedarf bereitgestellt) • Umdruck/Foliensammlung zur Vorlesung
Language	German
Examination Terms	Eine mündliche Prüfung
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr.-Ing. Klaus M. Radermacher
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	-
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Medical Engineering II (401443301)	6th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Vorlesung/Übung Medizintechnik II	6th semester	no semester recommended	-	4

Module titel	NC-Programming of Machine Tools (Compulsory elective subject)
Identifier	4011045
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2015
Valid until	-
Module level	Bachelor/Master
Content	1 • Einführung in die Vorlesung • Allgemeiner Aufbau von Werkzeugmaschinen • Bearbeitungsverfahren: Fräsen, Drehen • Labor: Hallenrundgang mit Vorstellung der in der Vorlesung verwendeten Werkzeugmaschinen 2 • Grundlagen der NC-Programmierung • Labor: Einweisung Programmierplätze 3 • Grundlagen der manuellen NC-Programmierung nach DIN 66025 • Labor: Einrichten von Werkzeugen (konventionelles Vorgehen) 4 • Erstellen von NC-Programmen nach DIN 66025, Teil I • Programmierübungen (nach DIN 66025), Teil I • Labor: Aufspannen und Einrichten von Rohteilen (konventionelles Vorgehen) 5 • Erstellen von NC-Programmen nach DIN 66025, Teil II • Programmierübungen (nach DIN 66025), Teil II • Labor: Fertigung eines manuell nach DIN 66025 programmierten Bauteils auf der Werkzeugmaschine 6 • Einführung in die Steuerung Sinumerik 840d von Siemens • Grundlagen und allgemeines Vorgehen zur NC-Programmierung mit ShopMill, ShopTurn • Labor: Praktische Einführung in die Bedienung einer WZM über die Siemens-Steuerung, Verwendung der Antastzyklen von ShopMill, ShopTurn 7 • NC-Programmierung von Drehteilen mit ShopTurn • NC-Programmierung von Frästeilen mit ShopMill • Programmierübungen • Labor: Fertigung eines in ShopMill, ShopTurn programmierten Bauteils auf der Werkzeugmaschine 8 • Einführung in die Steuerung iTNC 530 von Heidenhain • Grundlagen und allgemeines Vorgehen zu NC-Programmierung mit Klartext-Dialog • Labor: Einrichten von Werkzeugen unter der Benutzung eines Lasermessverfahrens 9 • NC-Programmierung von Frästeilen mit Klartext-Dialog • Programmierübungen mit Klartext-Dialog • Labor: Aufspannen und Einrichten von Rohteilen mit dem Tastsensor

	10 • Zyklenprogrammierung mit Klartext-Dialog • Programmierübungen mit Klartext-Dialog zum Thema Zyklenprogrammierung • Labor: Fertigung eines in Klartext-Dialog programmierten Bauteils auf der Werkzeugmaschine 11 • Grundlagen der NC-Programmierung mit CAM-Systemen • NC-Programmierung mit den CAM-Systemen NX6 und ExaptPlus • Programmierübungen • Labor: Übertragung von NC-Programmen aus CAM-Systemen auf die Steuerung der Werkzeugmaschine 12 • Ausblick • 5-Achs-Fräsen • CAD-CAM-NC-Kette • Labor: Vorführung eines 5-achs-simultan Fräsprozesses
Learning Objectives/ Learning Outcomes	Bezugswissenschaftliche Kompetenzen: • Die Vorlesung vermittelt den Studierenden einen vollständigen Überblick über die erforderlichen Arbeitsschritte zur Fertigung manuell programmierbarer Bauteile an modernen, NC-gesteuerten Werkzeugmaschinen. • Im Fokus der Vorlesung steht das Erlernen unterschiedlicher manueller NC-Programmierverfahren. Insbesondere werden den Studierenden Kenntnisse in der Programmierung nach DIN 66025 (G-Code) vermittelt, sowie die NC-Programmierung mit herstellungsspezifischer Software wie ShopMill, ShopTurn (Siemens) bzw. Klartext-Dialog (Heidenhain). Zusätzlich erlernen die Studierenden die Grundlagen der NC-Programmierung mit CAM-Systemen an den Beispielen Siemens, NX6 und ExaptPlus. • Durch die Möglichkeit NC-Programme direkt an realen Werkzeugmaschinen zu testen, werden die Studierenden zusätzlich praktische Erfahrungen im Bereich der Bedienung der zur Verfügung stehenden Werkzeugmaschinen sammeln können. Unter anderem stehen dabei die Auswahl und Einrichtung geeigneter Werkzeuge, sowie das Festlegen des Werkstücknullpunktes im Arbeitsraum im Vordergrund. Überfachliche allgemeine Kompetenzen (z.B. Teamarbeit, Präsentation, Projektmanagement, etc.): • Die Teamarbeit und Kommunikation zwischen den Studierenden wird in Gruppenübungen gefördert. • Verantwortungsbewusster Umgang mit Werkzeugmaschinen und den Studierenden anvertrautem Material.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Empfohlene Voraussetzungen: • Werkzeugmaschinen
References	• Vorlesungsunterlagen, Vordrucke im WZL erhältlich bzw. Unterlagen zum Download • Brecher, C.;Weck, M.: Werkzeugmaschinen, Band 1-5, 8. Auflage, Springer-Verlag
Language	German
Examination Terms	Eine schriftliche Klausur
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr.-Ing. Christian Brecher
ECTS Credits	4

– Applied Courses
– Mechanical Engineering
+ NC-Programming of Machine Tools (4011045)

Contact time (WSH)	3
Examination duration (min)	-
Total hours (h)	120,0
Contact hours (h)	45,0
Self-study hours (h)	75,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
NC-Programming of Machine Tools (401104501)	6th semester	no semester recommended	4	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Übung NC-Programmierung von Werkzeugmaschinen	6th semester	no semester recommended	-	1
Vorlesung NC-Programmierung von Werkzeugmaschinen	6th semester	no semester recommended	-	2

Module titel	Rapid Control Prototyping (Compulsory elective subject)
Identifier	4012548
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Summer semester 2011
Valid until	-
Module level	Master
Content	1 • Systembegriff • Mathematische Grundlagen für die Darstellung linearer Systeme inklusive Zustandsraumdarstellung • Definition kontinuierlicher bzw. ereignisdiskreter Systeme 2 • Einführung in die Regelungstechnik • Laplace-Transformation • Frequenzgang und Darstellung von Frequenzgängen • Lineare Regelkreisglieder • Z-Transformation 3 • Einführung in die physikalische Modellbildung • Aufstellen von Differentialgleichungen für dynamische Systeme • Aufstellen von Wirkungsplänen linearer Systeme 4 • Einführung in Matlab/Simulink • Grundlagen in Matlab • Grundlagen in Simulink 5 • Ereignisdiskrete Modellbildung • Eigenschaften von Beschreibungsmitteln • Einführung in Graphentheorie, Statecharts und Petri-Netze 6 • Einführung in die Identifikation dynamischer Systeme • Nichtparametrische Identifikationsverfahren • Korrelationsverfahren • Fourier-Transformation und Fast Fourier-Transformation 7 • Parametrische Identifikationsverfahren • Nichtrekursive Parameterschätzung • Rekursive Parameterschätzung 8 • Identifikation mittels der Gewichtsfolgenschätzung • Identifikation von nichtlinearen Prozessen • Shannon-Theorem 9 • Grundzüge des Regelungsentwurfs • Grundlagen des Regelkreises • Einführung in verschiedene Entwurfsverfahren für Regelkreisstruktur, Reglerstruktur und Reglerparameter

	10 • Grundzüge des Steuerungsentwurfs • Begriffsdefinitionen für Steuerungen • Entwurfsverfahren für diskrete Steuerungen 11 • Kontinuierliche und diskrete Simulation • Verfahren nach Euler, Heun und Runge-Kutta • Diskrete und hybride Simulation mit Stateflow 12 • Einführung in die objektorientierte Modellierung mit Modelica/Dymola • Grundzüge der Modellierungssprache Modelica • Modellierung eines Dreitankmodells in Dymola 13 • Rapid Control Prototyping • Anforderungen an ein RCP-System • Entwicklungsphasen (Software-in-the-loop, Hardware-in-the-loop) • Codegenerierung
Learning Objectives/ Learning Outcomes	Fachbezogen: • Nach erfolgreichem Abschluss des Moduls sind die Studierenden in der Lage, die wesentlichen Schritte des Rapid Control Prototypings (RCP) selbständig zu unterscheiden und anzuwenden. • Sie kennen die wesentlichen Beschreibungsmittel für lineare Regelkreisglieder wie z.B. Frequenzgang sowie Zustandsraumdarstellung und können diese in der Praxis anwenden. • Die Studierenden können kontinuierliche bzw. ereignisdiskrete Prozesse beurteilen und diese mit Hilfe der physikalischen oder experimentellen Prozessanalyse bzw. den Mitteln der ereignisdiskreten Modellbildung untersuchen. • Aufbauend auf den ermittelten Systembeschreibungen können die Studierenden geeignete Regelverfahren auswählen sowie die erforderlichen Reglerparameter für P-, PD-, bzw. PID-Regler bestimmen und somit eine einschleifige Regelung für das System entwerfen. • Die Studierenden sind in der Lage, die wesentlichen Simulationsverfahren sowohl für die kontinuierliche als auch für die ereignisdiskrete Simulation zusammenzufassen und anzuwenden. Die Grundlagen der hybriden Simulation sind ihnen bekannt. • Die Unterschiede zwischen dem objektorientierten Ansatz der Modellierungssprache Modelica und dem signalorientierten Ansatz in Simulink sind den Studierenden bekannt. Sie sind in der Lage, mit Hilfe des Simulationstools Dymola Systeme auf Basis der objektorientierten physikalischen Modellbildung zu simulieren. • Die für das RCP typischen Begriffe Software-in-the-Loop und Hardware-in-the-Loop können von den Studierenden unterschieden werden. Weiterhin sind ihnen die Entwicklungsphasen sowie die Code-Generierung als wesentlicher Bestandteil des RCP bekannt. Typische Hard- und Software für das RCP können von den Studierenden benannt werden. Nicht fachbezogen (z.B. Teamarbeit, Präsentation, Projektmanagement, etc.): • Die Studierenden können während der Übung die Inhalte der Vorlesung an praxisorientierten Beispielen in Gruppen von maximal 3 Studierenden an einem PC vertiefen, so dass Teamarbeit gefördert wird.
(Study-Specific) Prerequisites	-
(recommended) Requirements	-
References	• D. Abel; A. Bollig: Rapid Control Prototyping; Springer Verlag, ISBN: 3-540-29524-0 • D. Abel: Regelungstechnik (Umdruck zur Vorlesung)
Language	German
Examination Terms	Eine mündliche Prüfung
Miscellaneous	-

Module coordinator	Prof. Dr.-Ing. Heike Vallery
ECTS Credits	6
Contact time (WSH)	0
Examination duration (min)	0
Total hours (h)	180,0
Contact hours (h)	,0
Self-study hours (h)	180,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Rapid Control Prototyping (401254801)	4th semester	no semester recommended	6	0

Module titel	Simulation Methods in Mechanical Engineering (Compulsory elective subject)
Identifier	4010839
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Summer semester 2018
Valid until	-
Module level	Bachelor
Content	1. Introduction to systems theory. Historical presentation, definition of the terms system, model, simulation 2. Theory of concentrated dynamic systems I: examples of systems, principles in the form of mathematical equations, rest positions 3. Theory of concentrated dynamic systems II: linearization of models at a rest position, case study Lotka-Volterra predator-prey model as nonlinear and linearized system 4. Representation of models in simulation tools: graphical or linguistic, procedural or declarative representation, Electrical circuits and differential algebraic systems: equations for inductivity, capacity, resistant. Models of simple circuits are linear differential algebraic systems. 5. Mechanical systems: equations of movement, examples, modeling of mechanical systems 6. Thermodynamic systems: balance equations, examples, modeling of thermdynamic systems 7. Structured systems: Coupling of subsystems, aggretated systems, structured linear systems and their mathematical representation, model libraries 8. Object orientated modeling: introduction to the object orientated modeling language Modelica, reuse of subsystems, complex systems, examples 9. Discrete systems: Petri nets, disrete-event simulation, examples 10. Discrete and discrete-continous systems, finite automatons, hybric automatons, examples, numerical methods 11. Partial differential equations in structural mechanics: from truss to plane-stress plate, finite element method (FE) 12. Partial differential equations in fluid dynamics: Navier-Stokes equations, finite volume method (FV) 13. Simplfied example: Heat equation. FE and FV discretization, numerical solution, visualization 14. Uncertainties in computer-based analysis of PDEs: instabilities, resolution, requierements, nonlinearities, model insufficiences 15. Introduction to computer architectures: Moore's law, parallelization and ist consequences for computer-based analysis by PDEs
Learning Objectives/ Learning Outcomes	With respect to the subject: • The module Simulation Techniques imparts knowlegde to solve simulation tasks independently. On the one hand the students learn to propose mathematical models on their own. On the other hand they learn to apply simulation software to the proposed models. • The students know the basic system classes of simulations: concentrated dynamic systems, distributed dynamic systems, discrete systems and discrete-continous systems. • The students realize that the modeling of tasks of different engineering and physical disciplins induce mathematical models which can be represented by the same mathematical formulation. • The students acquire knowlegde of different simulation tools (especially Matlab/ Simulink). Not with respect to the subject (e.g. Team work, Presentation, Project Management, etc.):

	• In the tutorials and the laboratory the students learn the communication with the trainer and fellow students if problems cannot be solved independently.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Recommended Requirements (e.g. other Modules): • Mathematics I-III • Thermodynamics I,II • Mechanics I-III • Computer Science in Mechanical Engineering
References	• Bruns, M. (1991). Systemtechnik. Methoden zur interdisziplinären Systementwicklung. Springer. Berlin. • Föllinger, Franke (1982). Einführung in die Zustandsbeschreibung dynamischer Systeme. Oldenbourg Verlag. • Angermann, A., M. Beuschel, M. Rau und U. Wohlfarth (2004). Matlab - Simulink - Stateflow. Oldenbourg Verlag. • Zeigler, B. P., H. Praehofer und T.G. Kim (2000): Theory of Modeling and Simulation, 2nd Edition, Academic Press, San Diego. • Blaß;, E. (1997). Entwicklung verfahrenstechnischer Prozesse. Springer. Berlin. • Schmidt, G. (1980). Simulationstechnik. R. Oldenbourg. München. • Fritzson, P. (2004) Object-Oriented Modeling and Simulation with Modelica 2.1. IEEE Press, Piscataway (USA). • Patzak, G. (1982). Systemtechnik - Planung komplexer innovativer Systeme. Springer. Berlin. • Zeigler, B.P. (1984). Multi-facetted Modeling and Discrete Event Simulation. Academic Press. London. • Quarteroni, A., Saleri, F. (2006). Wissenschaftliches Rechnen mit MATLAB. • Knabner, P., Angermann, L. (2000). Numerik partieller Differentialgleichungen.
Language	German
Examination Terms	A written exam. Bonus points: A Maximum of 10% of the points of the exam can be gathered with bonus points. A grade improvement from 5.0 to 4.0 with bonus points is not possible. The bonus points remain for one year.
Miscellaneous	-
Module coordinator	Universitätsprofessor Marek Behr Ph. D. Universitätsprofessor Alexander Mitsos Ph. D.
ECTS Credits	6
Contact time (WSH)	6
Examination duration (min)	-
Total hours (h)	180,0
Contact hours (h)	90,0
Self-study hours (h)	90,0

+ Simulation Methods in Mechanical Engineering (4010839)

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Simulation Methods in Mechanical Engineering (401083901)	4th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Laboratory Simulation Methods in Mechanical Engineering	4th semester	no semester recommended	-	2
Exercise Simulation Methods in Mechanical Engineering	4th semester	no semester recommended	-	1
Lecture Simulation Methods in Mechanical Engineering	4th semester	no semester recommended	-	3

Module titel	Medical Software Engineering (Compulsory elective subject)
Identifier	4011672
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Summer semester 2014
Valid until	-
Module level	Master
Content	Vermittelt werden die gesetzlichen Anforderungen an die Softwareentwicklung in der Medizintechnik, welche an praktischen Beispielen in den Übungen umgesetzt werden. Dabei werden alle Teile des Software-Lebenszyklus von der Anforderungsanalyse über das Software-Design bis hin zur Implementierung und Verifikation behandelt. Ein weiterer Schwerpunkt liegt in Methoden der Risikoanalyse und -Beherrschung.
Learning Objectives/ Learning Outcomes	Wissen und Verstehen: die Studierenden kennen im Bereich der Softwareentwicklung in der Medizintechnik - gängige Anwendungsfelder - mögliche Entwicklungsprozesse - aktuelle gesetzliche Anforderungen - Risiken, die von der Software und dem verwendeten Softwareentwicklungsprozess ausgehen können - Methoden zur Risikobewertung und zur Risikobeherrschung Fertigkeiten und Kompetenzen: Die Studierenden besitzen ein Verständnis für die Risiken, die von dem Softwareentwicklungsprozess ausgehen und beherrschen Methoden, die Risiken zu analysieren und zu minimieren. Sie sind in der Lage, einen geeigneten Entwicklungsprozess für den gesamten Lebenszyklus der Software anzuwenden. Die Studierenden sind in der Lage, die Software zu entwerfen, in C++ zu implementieren und dabei Methoden der Risikoanalyse (FMEA/FTA) und des Qualitätsmanagements (u.a. SVN) anzuwenden.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Empfohlene Voraussetzungen: Kentnisse in Objektorientiertem Softwaredesign Erfahrungen in einer objektorientierten Programmiersprache (JAVA, C/C++, C#,...)
References	Folien zur Vorlesung und Übungsblätter Empfohlene weiterführende Literatur: Normen:IEC 62304 W. Niederlag, H.U. Lemke, G. Strauss, H. Feussner: Der digitale Operationssaal. 2.Auflage, De Gruyter Verlag 2014
Language	German
Examination Terms	Die Endote ergibt sich aus der Benotung der Projektarbeit (70%) und des Kolloquiums (30%).
Miscellaneous	-

– Applied Courses
– Mechanical Engineering
+ Medical Software Engineering (4011672)

Module coordinator	Dr.-Ing. Matías de la Fuente Klein
ECTS Credits	4
Contact time (WSH)	3
Examination duration (min)	-
Total hours (h)	120,0
Contact hours (h)	45,0
Self-study hours (h)	75,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Medical Software Engineering (40116721)	4th semester	no semester recommended	4	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Übung (Praktikum) Softwareentwicklung in der Medizintechnik	4th semester	no semester recommended	-	2
Vorlesung Softwareentwicklung in der Medizintechnik	4th semester	no semester recommended	-	1

Module titel	Basics of Electrical Engineering for Mechatronic Systems (Compulsory elective subject)
Identifier	4017217
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Summer semester 2018
Valid until	-
Module level	Bachelor
Content	Der Maschinenbau lebt von den bewegten Anlagen, stationären (Werkzeugmaschinen oder Roboter) und mobilen (fahrerlose Transportsysteme oder Automobile). Diese Anlagen basieren auf den drei Säulen Mechanik, Elektronik und Software. Die dabei verwendeten elektrischen Antriebe und ihre Steuerung dienen als "roter Faden" für die Darstellung physikalischer Grundprinzipien und leiten von den elektrotechnischen Grundlagen über elektrodynamische Energiewandler zur elektronischen Steuerungstechnik, die zusammen mit der Messtechnik eine wichtige Voraussetzung für die Automatisierungstechnik ist. Die Vorlesung soll den Studierenden des Maschinenbaus grundlegende, fundierte Kenntnisse der Elektrotechnik beibringen. Weiterhin sollen besonders die Schnittstellen zur Mechanik und Software dargestellt und verdeutlicht werden. In den ersten Vorlesungen werden die Themen Spannung, Strom und Energie behandelt um die Grundlagen für das Verständnis von Gleichstromnetzwerken zu legen. Anschließend werden die elektrischen Phänomene wie magnetisches Feld, Lorenzkraft, Induktion etc. behandelt um mithilfe dieser Begrifflichkeiten Schaltvorgänge sowie elektrische Maschinen erklären zu können. Die Vorlesung schließt mit der Betrachtung von Wechselstromnetzwerken und den damit verbundenen elektrischen Motoren, sowie den Grundlagen der Signalverarbeitung.
Learning Objectives/ Learning Outcomes	Wissen und Verstehen: • Spannung, Strom, Energie • DC-Netzwerke • Elektrisches Feld / Kondensator • Magnetisches Feld, Lorenzkraft, Induktion • Schaltvorgänge • Elektrische Maschinen 1 • AC-Netzwerke und Transformatoren • Drehstrom • Elektrische Maschinen 2 • Halbleiter / Elektrische und elektronische Schalter • Stromrichter • Signalverarbeitung Fertigkeiten und Kompetenzen: Die Studierenden kennen die im Abschnitt "Wissen und Verstehen" (s.o.) bzw. "Inhalt" (s.u.) angegebenen Begrifflichkeiten und sind in der Lage, Anwendungen in diesen Bereichen mit dem ihnen als "Werkzeug" vermittelten Wissen theoretisch und praktisch zu durchdringen.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Empfohlene Voraussetzungen: - Physik - Mathematik I

References	• Vorlesungsmaterialien • Weitere Literatur laut Angaben in der Vorlesung
Language	German
Examination Terms	Note: Die Endnote ergibt sich aus der Note der Klausur. Bonuspunkte: Auf Klausurbearbeitungen, mit denen Studierende ohne Hinzurechnung von Bonuspunkten mindestens die Note 4,0 erreichen, können bis zu 10% der erreichbaren Gesamtpunktzahl als Bonuspunkte angerechnet werden. Diese Bonuspunkte können durch die Online-Bearbeitung von Selbstrechenübungen, die einzeln und unabhängig voneinander bewertet werden, erlangt werden.
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr.-Ing. Jakob Andert
ECTS Credits	6
Contact time (WSH)	5
Examination duration (min)	-
Total hours (h)	180,0
Contact hours (h)	75,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Basics of Electrical Engineering for Mechatronic Systems (401721701)	4th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Basics of Electrical Engineering for Mechatronic Systems	4th semester	no semester recommended	-	3
Exercise Basics of Electrical Engineering for Mechatronic Systems	4th semester	no semester recommended	-	2

Module titel	Machine Design I (Compulsory elective subject)
Identifier	4016442
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2017
Valid until	-
Module level	Bachelor
Content	V0: Einführung in die Systemanalyse, Definitionen: System, Zweck Ü0: Analyse eines beispielhaften Maschinensystems. Vorstellung des Systems und seiner Funktionen (Vorlesung, Übung entfällt) V1: Analyse eines beispielhaften Maschinensystems. Arten von Funktionsstrukturen, Identifikation von Haupt- und Teilfunktionen. Teilfunktionen isolieren. Definition von Hauptflüssen (Maschine, Apparat, Gerät) Ü1: Aufstellen von Funktionsstrukturen, Klassifizierung von Zwecken und Hauptflüssen V2: Analyse eines beispielhaften Maschinensystems. Definition: Prinziplösung, physikalischer Effekt, Effektträger, qualitative Gestaltparameter des Wirkorts, Kraftfluss und Leitstützstruktur Ü2: Identifizierung und Kennzeichnung von physikalischen Effekten, Wirkflächen und Kraftflüssen V3: Funktionen von Maschinenelementen. Physikalische Wirkweise, Zweck, Einsatzbereiche und Ausprägungen von Federn, Verbindungen, und mechanischen Getrieben anhand des beispielhaften Maschinensystems. Klassifizierung von Verbindungen (Form-, Kraft und Stoffschluss), Anwendungsfälle Ü3: Ausprägungen und Funktionsweisen von Federn, Verbindungen und mechanischen Getrieben V4: Funktionen von Maschinenelementen. Physikalische Wirkweise, Zweck, Einsatzbereiche und Ausprägungen von Kupplungen, Lagerungen und Dichtungen anhand des beispielhaften Maschinensystems Ü4: Ausprägungen und Funktionsweisen von Kupplungen, Lagerungen und Dichtungen V5: Technische Dokumentation. Zweck, Arten und Inhalt der von der Konstruktion erzeugten Dokumente, Mehrtafelprojektion, Elemente der technischen Zeichnung, Linienarten und –breiten, Aufbau, Stücklisten. Ü5: Vorbereitung eines Zeichnungssatzes: Schriftfeld, Liniengruppen, Dreitafelprojektion V6: Technische Dokumentation. Zweck und Arten der Schnittdarstellung: Grundlagen, Kennzeichnung von Schnitten- und Schnittverläufen, Vollschnitt, Halbschnitt, Stufenschnitt, abgeknickter Schnittverlauf, Ausbrüche und Detailansichten Ü6: Darstellung von Schnitten- und Schnittverläufen, Vollschnitt, Halbschnitt, Stufenschnitt, abgeknicktem Schnittverlauf, Ausbrüchen und Detailansichten V7: Fertigungsgerechte Bemaßung. Funktions-, prüf- und fertigungsgerechte Bemaßung; Wahl der Bezugsflächen; parallele, steigende und Koordinaten-Bemaßung Ü7: Fertigungsgerechte Bemaßung von Drehteilen und prismatischen Teilen V8: Darstellung von Maschinenelementen. Aufbau, technische Darstellung und grundlegende Gestaltung: Federn, Welle-Nabe-Verbindungen und Schrauben Ü8: Darstellung und Gestaltung von Federn, Welle-Nabe-Verbindungen und Schraubverbindungen V9: Darstellung von Maschinenelementen. Aufbau, technische Darstellung und grundlegende Gestaltung: Kupplungen und Zahnräder. Zahnradpaarungen: Kenngrößen, Gestaltungs- und Darstellungsregeln Ü9: Darstellung und Gestaltung von Kupplungen und Zahnrädern. V10: Darstellung von Maschinenelementen. Aufbau, technische Darstellung und grundlegende Gestaltung: Wälzlager und Dichtungen Ü10: Darstellung und Gestaltung von Wälzlagern und Dichtungen V11: Fertigungsgerechte Bemaßung. Maßtoleranzen und Passungen, Begriffsbestimmungen, direkter Zeichnungseintrag, Allgemeintoleranzen, ISO-Toleranzfelder Ü11: ISO-Toleranzen bestimmen
Learning Objectives/ Learning Outcomes	Angestrebte Lernergebnisse Nach erfolgreicher Teilnahme an den Modulveranstaltungen haben die Studierenden Kenntnisse und Fähigkeiten in den Themenfeldern erworben, die unter Inhalt beschrieben werden. Wissen und Verstehen: Die Studierenden haben grundlegende Kenntnisse zu nachfolgenden Themen: • Analyse, Interpretation und Variation technischer Systemen hinsichtlich funktionaler Aspekte. Konstruktionsmethodische Werkzeuge wie Grundlagen der Funktionsanalyse und Wirkprinzipien; • Funktion und Ausprägungen von häufig eingesetzten Maschinenelementen zur Realisierung von Federn, Verbindungen, mechanischen Getrieben, Kupplungen, Lagerungen und Dichtungen;

	• Technische Sachverhalte, insbesondere die Gestalt von einzelnen Maschinenelementen und deren Struktur und Funktion in der Einbausituation in mechanischen Baugruppen anhand einer Zeichnung mit genormter Darstellungsweise verstehen, interpretieren und selbst dokumentieren; • Grundlagen der konventionellen Fertigungsverfahren und Anwendung dieser Kenntnisse bei der Gestaltung und Bemaßung; • Zweck, Aufbau und Anwendung von Normwerken. Fertigkeiten und Kompetenzen: Durch die Lehrveranstaltung mit Vorlesungen und begleitenden Übungen sind die Studierenden in der Lage, selbstständig grundlegende technische Zusammenhänge von Maschinensystemen zu erkennen. Die Studierenden haben die Fähigkeit entwickelt, Maschinensysteme mithilfe einfacher konstruktionsmethodischer Werkzeuge hinsichtlich ihrer Funktion zu analysieren. In diesem Zusammenhang haben die Studierenden die einschlägigen technischen Normen und Darstellungsweisen für Maschinenelemente und -bauteile kennengelernt und können diese bedarfsgerecht anwenden. Dies beinhaltet insbesondere das normgerechte Zeichnen, Skizzieren und Bezeichnen der jeweiligen Maschinenelemente. Durch die entwickelten Fertigkeiten haben die Studierenden ein grundlegendes Verständnis für die Funktionen und Ausprägungen häufig verwendeter Maschinenelemente und -systeme entwickelt. Die erlernten Techniken und Methoden befähigen die Studierenden zur Analyse und Darstellung weiterer Maschinensysteme. Das Verständnis bestehender Systeme schafft damit die Voraussetzung für das Erlernen der Gestaltsynthese, d.h. die erfolgreiche Konstruktion neuer technischer Systeme in Maschinengestaltung II und III. Die Studierenden erlangen die Kompetenz, maschinenbauliche Konstruktionen eigenständig zu analysieren und diese in einem Team mit anderen Fachleuten zu diskutieren. Darüber hinaus sind die Studierenden in der Lage, die Ergebnisse ihrer Arbeit mündlich und schriftlich eindeutig darzustellen und wissenschaftlich fundiert zu vertreten. Sonstiges: Durch die Teilnahme am Modul und die selbständige Bearbeitung der Aufgaben verbessern die Studierenden darüber hinaus durch selbständigen Einsatz ihre Methodenkompetenz sowie ihr Projekt- und Zeitmanagement. Sie können sich den Lernprozess selbständig einteilen und in den zeitlichen Gesamtprozess des Studiums frist- und formgerecht einfügen.
(Study-Specific) Prerequisites	-
(recommended) Requirements	-
References	Hoischen: Technisches Zeichnen, jeweils aktuelle Ausgabe. Pahl, G.; Beitz, W.; Feldhusen, J.; Grote, K. H.: Konstruktionslehre, Grundlagen erfolgreicher Produktentwicklung, Methoden und Anwendung. 8.Auflage. Springer-Verlag 2013 (ausgesuchte Kapitel).
Language	German
Examination Terms	Die Benotung erfolgt durch eine Klausur. Informationen zur Bonuspunkte-Regelung: Die Prüfungsordnung ermöglicht, freiwillig eingereichte zusätzliche Übungsaufgaben als Bonuspunkte auf das Ergebnis der Klausur anrechnen zu lassen. In diesem Sinne werden für Maschinengestaltung I semesterbegleitend Zusatzaufgaben angeboten, um das Selbststudium, insbesondere das Systemverständnis und die Bearbeitung umfangreicherer Zeichnungen oder Konstruktionen, zu unterstützen. In drei selbstständig zu bearbeitenden Bonusaufgaben können insgesamt bis zu 10% der in der Klausur erzielbaren Punkte angesammelt werden, die somit zu einer Verbesserung der Note führen können. Aufgabe 1: E-Test: 2 Punkte Aufgabe 2: E-Test: 2 Punkte Aufgabe 3: Erstellung einer technischen Zeichnung (manuell): 8 Punkte. Die Bonuspunkte erhalten so lange ihre Gültigkeit bis sie im darauf folgenden Jahr erneut erlangt werden können, danach verfallen sie. Eine Notenverbesserung von 5,0 auf 4,0 ist durch Bonuspunkte möglich. Für Details zu den Zusatzaufgaben und zur Organisation wird auf die erste Vorlesung und das entsprechende Material im L2P Raum zur Veranstaltung verwiesen.
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Thomas Fieder B. Sc.Modellierungsteamverantwortlicher: Michael Sauer B. Sc.Modulverantworlicher: Universitätsprofessor Dr.-Ing. Georg Jacobs

ECTS Credits	3
Contact time (WSH)	3
Examination duration (min)	0
Total hours (h)	90,0
Contact hours (h)	45,0
Self-study hours (h)	45,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Machine Design I (401644201)	3rd semester	no semester recommended	3	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Vorlesung Maschinengestaltung I	3rd semester	no semester recommended	-	1
Tutorengruppe Maschinengestaltung I	3rd semester	no semester recommended	-	0
Übung Maschinengestaltung I	3rd semester	no semester recommended	-	2

Module titel	Automated and Connected Driving Challenges - Course (Compulsory elective subject)
Identifier	4025905
Version	v1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2021
Valid until	-
Module level	Master
Content	This module introduces students to current research challenges in the field of automated and connected driving. In the subsequent module "Automated and Connected Driving Challenges - Research Project", students may then conduct their own a research. This is not mandatory though. This module provides the theoretical and practical foundations, which enable students to conduct their own research in the field of automated and connected driving. The challenges predominantly come from current national and international research projects. Students therefore get the chance to get introduced to current research challenges, to contribute to them and to publish a research paper. In this module, students gain experience in the following aspects: • function development for automated and connected vehicles, • programming in Python and C++, • development of software modules for the Robot Operating System, • artificial intelligence, deep learning, neural networks, • sensor data processing (camera, lidar, ...), • environment modeling (data filtering, data fusion, object tracking), • behavior planning (route planning, maneuver planning, trajectory planning), • cooperative and connected driving.
Learning Objectives/ Learning Outcomes	Knowledge and Understanding: Students can • name and explain current research challenges in automated and connected driving • name and describe the most important functions of automated and connected vehicles. • explain how different software modules in automated and connected vehicles interact. • explain the role of AI technology in automated and connected driving. • name and explain the basic features of the Robot Operating System. Skills and Competencies: Students • are able to contribute to current research challenges in automated and connected driving. • can program functions for automated and connected vehicles using Python and C++. • can integrate their developed functions into the Robot Operating System. • can train neural networks, e.g. with Tensorflow. • are able to evaluate their developed functions.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Recommended Prerequisites: • Basic programming experience (Python, C++) • Basic experience with Linux The module "Automotive Engineering IV - Automated Driving" can be helpful for understanding the content of this module.
References	Deep Learning - I. Goodfellow, Y. Bengio, A. Courville

	Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow - A. Géron
Language	English
Examination Terms	The course grade results 100% from the exam grade.
Miscellaneous	-
Module coordinator	Univ.-Prof. Dr.-Ing. Lutz Eckstein
ECTS Credits	4
Contact time (WSH)	2
Examination duration (min)	-
Total hours (h)	120,0
Contact hours (h)	30,0
Self-study hours (h)	90,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Automated and Connected Driving Challenges - Course (402590501)	3rd semester	no semester recommended	4	-

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Automated and Connected Driving Challenges - Course	3rd semester	no semester recommended	-	2

Module titel	Automated and Connected Driving Challenges - Research Project (Compulsory elective subject)
Identifier	4025906
Version	-
Duration (Semester)	three semesters
Cycle (Semester)	summer semester
Valid from	Summer semester 2022
Valid until	-
Module level	Master
Content	In this module, students will conduct a research project where they contribute to one of the current research challenges in the field of Automated and Connected Driving. These challenges are explained in the module "Automated and Connected Driving Challenges - Course", which students should take before this module, unless they have already acquired corresponding skills elsewhere. Students can use their gained experience from the above course to conduct their own research. Students will be supported in their efforts by the course team. The challenges predominantly come from current national and international research projects. Students therefore get the chance to contribute to the latest research challenges and to publish a research paper. Students will deepen their experience in multiple of the following aspects: • function development for automated and connected vehicles, • programming in Python and C++, • development of software modules for the Robot Operating System, • artificial intelligence, deep learning, neural networks, • sensor data processing (camera, lidar, ...), • environment modeling (data filtering, data fusion, object tracking), • behavior planning (route planning, maneuver planning, trajectory planning), • cooperative and connected driving. The research project can also be conducted by a group of students. At the end of the course, students hand in a short research paper, their developed source code and explain their finished project in a presentation. The research project can serve as a good opportunity to prepare for a master thesis.
Learning Objectives/ Learning Outcomes	Knowledge and Understanding: Students can • name and explain current research challenges in automated and connected driving. • name and explain one of those research challenges, which is chosen for their research project, in particular detail. • name and explain related literature and research approaches that contribute to their research project. • explain the approach they chose to tackle the research challenge of their research project. Skills and Competencies: Students • are able to contribute to current research challenges in automated and connected driving. • can program functions for automated and connected vehicles using Python and C++. • can integrate their developed functions into the Robot Operating System. • can train neural networks, e.g. with Tensorflow. • are able to evaluate their developed functions. • are able to contribute to one specific research challenge in a (group) research project. • are able to describe and explain their work in a research paper. • are able to describe and explain their work in a presentation.

(Study-Specific) Prerequisites	-
(recommended) Requirements	Recommended Prerequisites: • The module "Automated and Connected Driving Challenges - Course" should be taken before this one. • Programming experience (Python, C++) • Experience with Linux • Experience with the Robot Operating System
References	Deep Learning - I. Goodfellow, Y. Bengio, A. Courville Hands-On Machine Learning with Scikit-Learn, Keras, and TensorFlow - A. Géron
Language	English
Examination Terms	The grade of the research project is the grade of the presentation (composed of 7/10 short paper + code (homework) and 3/10 oral presentation)
Miscellaneous	-
Module coordinator	Univ.-Prof. Dr.-Ing. Lutz Eckstein
ECTS Credits	5
Contact time (WSH)	1
Examination duration (min)	-
Total hours (h)	150,0
Contact hours (h)	15,0
Self-study hours (h)	135,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Automated and Connected Driving Challenges - Research Project (402590601)	4th semester	no semester recommended	5	-

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Automated and Connected Driving Challenges - Research Project	4th semester	no semester recommended	-	1

Module titel	Automated Driving (Compulsory elective subject)
Identifier	4020493
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Summer semester 2023
Valid until	-
Module level	Master
Content	1. Einführung in das automatisierte Fahren 2. Methodische Grundlagen für das automatisierte Fahren 3. Sensorik 4. Wahrnehmung 5. Umfeldmodellierung 6. Situationsverstehen 7. Verhaltensplanung 8. Bewegungsplanung und Trajektorienoptimierung 9. Fahrzeug-Regelung 10. Architektur, Aktorik, HMI und Steuergeräte 11. Kooperation, V2X und cloudbasierte Funktionen 12. Entwicklungsprozess und Simulation 13. Absicherung und Wirksamkeitsanalyse
Learning Objectives/ Learning Outcomes	• Die Studierenden kennen die wesentlichen funktionalen Konzepte und Definitionen sowie Software- und Hardware-Komponenten automatisierter Fahrzeuge. • Die Studierenden verstehen die Funktionsweise der wesentlichen Software- und Hardware-Komponenten automatisierter Fahrzeuge und ihren Zusammenhang mit anderen Systemkomponenten. • Die Studierenden können anhand ihrer Kenntnisse automatisierte Fahrzeuge inklusive ihrer Funktionen analysieren und evaluieren.
(Study-Specific) Prerequisites	-
(recommended) Requirements	-
References	-
Language	English
Examination Terms	Eine schriftliche Prüfung
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr.-Ing. Lutz Eckstein
ECTS Credits	5
Contact time (WSH)	3
Examination duration (min)	-
Total hours (h)	150,0

Contact hours (h)	45,0
Self-study hours (h)	105,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Automated Driving (402049301)	4th semester	no semester recommended	5	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Automated Driving	4th semester	no semester recommended	-	2
Exercise Automated Driving	4th semester	no semester recommended	-	1

Module titel	System ergonomics (Compulsory elective subject)
Identifier	4012536
Version	V2
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2022
Valid until	-
Module level	Master
Content	• Behandlung von Systemeigenschaften wie Performanz, Sicherheit, Akzeptanz und Robustheit bzw. Resilienz • Balancierte Gestaltung von Mensch-Maschine Systemen in den Phasen Analyse, Anforderungserstellung, Design incl. des Interaktions- und Interface-Designs, Implementierung incl. Rapid Prototyping und Anknüpfungspunkte zum Concurrent Engineering • Evaluierung und Überprüfung incl. der Gebrauchstauglichkeitsüberprüfung (usability assessment)
Learning Objectives/ Learning Outcomes	Wissen und Verstehen: Die Studierenden erhalten einen historischen Überblick über die Wissenschaft, das Handwerk und die Kunst der Systemergonomie (Human Systems Integration). Es folgt eine Einführung in die theoretischen Grundlagen der Systemwissenschaft und des Systems Engineering, sowie in die physiologischen und psychologischen Eigenschaften des Menschen als wichtigen Teil eines Mensch-Maschine-Systems. Neben der Behandlung von Systemqualitäten wie Performance, Sicherheit, Akzeptanz und Robustheit bzw. Resilienz ist ein zentrales Lernziel der Vorlesung auch die Vermittlung von Methoden für die Gestaltung und Integration von Mensch-Maschine-Systemen in den Phasen Analyse, Anforderungsdefinition, Design inkl. Kooperations-, Interaktions- und Interfacedesign, Implementierung inkl. Rapid Prototyping und schließlich Evaluation inkl. Usability Assessment. Das Leitmotiv der Vorlesung, dynamisches Ausbalancieren von Spannungsfeldern, wird einerseits systemtheoretisch untermauert und mit aktuellen Beispielen illustriert. Fertigkeiten und Kompetenzen: Im Rahmen des Moduls Systemergonomie erwerben die Studierenden verschiedene Schlüsselkompetenzenden der menschgerechten, ausbalancierten Systemgestaltung und Entwicklung soziotechnischer Systeme. Neben der Sachkompetenz im Hinblick auf das erworbene Fachwissen im Bereich der Systemwissenschaft und der vom Systems Engineering abgeleiteten Human Systems Integration werden die Studierenden auch zum interdisziplinären und ganzheitlichen Denken animiert und angeregt. Erweitert wird dies durch die Methodenkompetenz, das theoretische Wissen aus der Vorlesung im Projekt auch praktisch anzuwenden, selbstständig Probleme zu analysieren, zu lösen und auch bestehende Lösungen kritisch zu hinterfragen. Die interdisziplinäre Bearbeitung der Projektarbeit erfordert die Kooperationsfähigkeit, Kommunikationsfähigkeit und Teamfähigkeit der Studierenden, dadurch wird im Rahmen des Moduls neben der Sach- und Methodenkompetenz auch die Sozialkompetenz der Studierenden geschärft.
(Study-Specific) Prerequisites	-

(recommended) Requirements	keine
References	-
Language	English
Examination Terms	Eine mündliche Prüfung (2/3) und eine Projektarbeit (1/3)
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr.-Ing. Frank Flemisch
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	-
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Balanced Human Systems Integration (401253601)	4th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Project Balanced Human Systems Integration	4th semester	no semester recommended	-	2
Lecture Balanced Human Systems Integration	4th semester	no semester recommended	-	2

Module titel	Fundamentals of Machine Learning (Compulsory elective subject)
Identifier	4011600
Version	V4
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2022
Valid until	-
Module level	Master
Content	The class "Computer Science in Mechanical Engineering II: Data Science and Machine Learning" covers state-of-the-art data science methods from computer science and their application in mechanical engineering. It introduces the core basics in probability theory, develops main principles and methods from machine learning, and provides an introduction to its modern tools. The class combines both profound understanding of basic concepts and theory in data science, as well as hand-on programming techniques applied on problems in the context of engineering. Class outline: 1. Probability theory 2. Linear models for regression 3. Linear models for classification 4. Neural networks and deep learning 5. Gaussian processes 6. Introduction to reinforcement learning
Learning Objectives/ Learning Outcomes	<u>Knowledge and Understanding</u> • The students know the fundamentals in probability theory and can apply them in advanced methods and problems • The students have an overview and understanding of core methods and tools in machine learning (regression, classification, reinforcement learning) • They have an in-depth understanding of core principles, problems, and techniques in data science and machine learning • They develop an understanding for what problems and purposes data science methods can be applied in mechanical engineering <u>Abilities and Competencies:</u> • The students acquire knowledge about methods and implementation of state-of-the-art machine learning (e.g., neural networks, Gaussian process regression) • They have the ability to apply the acquired knowledge to problems in the context of mechanical engineering by using appropriate methods and programming tools
(Study-Specific) Prerequisites	-
(recommended) Requirements	-
References	Will be announced in class. Recommended further literature: Bishop, Christopher M., Pattern recognition and machine learning. Springer, 2006. Sutton, Richard S., and Andrew G. Barto, Reinforcement learning: An introduction (second edition). MIT press, 2018.

	Goodfellow, Ian, Yoshua Bengio, and Aaron Courville, Deep learning. MIT press, 2016. Carl Edward Rasmussen and Christopher K. I. Williams, Gaussian processes for machine learning, MIT press, 2006.
Language	English
Examination Terms	Written final exam (100 %)
Miscellaneous	-
Module coordinator	Univ.-Prof. Dr.-Ing. Johann Sebastian Trimpe
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	-
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Fundamentals of Machine Learning (401160001)	3rd semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Fundamentals of Machine Learning	3rd semester	no semester recommended	-	2
Exercise Fundamentals of Machine Learning	3rd semester	no semester recommended	-	2

Module titel	Numerical Analysis I (Compulsory elective subject)
Identifier	1114980
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2006
Valid until	-
Module level	Bachelor/Master
Content	Fehleranalyse, Kondition, Rundungsfehler, Stabilität, Direkte Lösungsverfahren für lineare Gleichungssysteme, Lineare Ausgleichsrechnung, Iteratives Lösen nichtlinearer Gleichungssysteme, Nichtlineare Ausgleichsrechnung, Lösen von Eigenwertproblemen
Learning Objectives/ Learning Outcomes	Die Studierenden sollen Verständnis für grundlegende Begriffe der numerischen Analysis, insbesondere der Kondition eines Problems und Stabilität eines Algorithmus und der darauf basierenden Fehleranalyse, entwickeln, die Fähigkeit erwerben, grundlegende numerische Methoden in ihrer Funktionsweise zu verstehen, die durch sie erreichbaren Ergebnisse einzuschätzen und darauf aufbauend in flexibler Anpassung an neue Aufgabenstellungen die Methode weiter zu entwickeln, die Grundbegriffe und Konzepte wie Matrixfaktorisierungen, Projektionen und iterative Lösungsansätze sicher beherrschen und die Fähigkeit zum aktiven Umgang mit den Gegenständen der Lehrveranstaltung erwerben und aufbauend auf diesen methodischen Werkzeugen erste grundlegende Konzepte für das approximative Lösen wissenschaftlicher und technischer Probleme aneignen.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Kenntnisse der Module Analysis I, Lineare Algebra I
References	W. Dahmen, A. Reusken, Numerik für Ingenieure und Naturwissenschaftler, Springer 2006; P. Deuflhard, A. Hohmann, Numerische Mathematik I, de Gruyter 2002; A. Reusken, Numerische Analysis I (Skript)
Language	German
Examination Terms	Zulassungsvoraussetzung: Lösen von Übungsaufgaben Prüfungsleistung: Bestehen einer Klausur oder mündlichen Prüfung; Prüfungsdauer und -art werden am Anfang des Semesters bekannt gegeben
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. rer. nat. Sebastian Noelle Universitätsprofessor Dr. rer. nat. Arnold Reusken
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	0

– Applied Courses
– Mathematics
+ Numerical Analysis I (1114980)

Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Numerical Analysis (111498002)	3rd semester	no semester recommended	0	2
Exam Numerical Analysis I (111498001)	3rd semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Numerical Analysis	3rd semester	no semester recommended	-	2

Practical Course in Mathematics (1112713)

Module titel	Practical Course in Mathematics (Compulsory elective subject)
Identifier	1112713
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Summer semester 2008
Valid until	-
Module level	Bachelor
Content	Wechselnde Fragestellungen und Algorithmen aus der diskreten Optimierung, Gruppentheorie, Zahlentheorie, linearen Algebra, Bildverarbeitung, Datenkompression, Numerik etc.
Learning Objectives/ Learning Outcomes	Knowledge Die Studierenden sollen lernen, für Probleme aus verschiedenen Gebieten der Mathematik effiziente algorithmische Lösungen zu entwickeln. Skills Sie sollen die Fähigkeit zur Umsetzung abstrakter Algorithmen in C++ Programme erwerben, Grundlagen erarbeiten, um Programmieraufgaben für andere mathematische Veranstaltungen des Bachelor-Studiums zu lösen, und... Competences ... Voraussetzungen schaffen, um später bei der mathematischen Simulation naturwissenschaftlicher und technischer Probleme mitzuwirken.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Keine
References	Wechselnd je nach behandelten Themen
Language	German
Examination Terms	The grade of the module results 100% from the lab course.
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Modulangebotsverantwortlicher Mathematik Modellierungsteamverantwortlicher: Dr. rer. nat. Katja Petzoldt Modulverantworlicher: Universitätsprofessor Dr. rer. nat. Sebastian Noelle apl. Professor Dr. rer. nat. Siegfried Müller Universitätsprofessor Dr. rer. nat. Arnold Reusken
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	0
Total hours (h)	180,0

Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Computer lab Practical Course in Mathematics (111271301)	4th semester	no semester recommended	6	2

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Tutorial on Mathematical Practical course	4th semester	no semester recommended	-	2

Module titel	Numerical Analysis II (Compulsory elective subject)
Identifier	1114981
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Summer semester 2007
Valid until	-
Module level	Bachelor/Master
Content	Approximation und Interpolation mit Polynomen, Spline-Funktionen, schnelle Fourier-Transformation, Numerische Integration
Learning Objectives/ Learning Outcomes	Die Studierenden sollen das Verständnis für grundlegende Begriffe der numerischen Analysis, insbesondere Kondition eines Problems und Stabilität eines Algorithmus sowie der darauf basierenden Fehleranalyse, vertiefen, die Fähigkeit erwerben, grundlegende numerische Methoden in ihrer Funktionsweise zu verstehen, die durch sie erreichbaren Ergebnisse einzuschätzen und darauf aufbauend in flexibler Anpassung an neue Aufgabenstellungen die Methode weiterzuentwickeln, Grundbegriffe und -techniken wie Interpolation, Glattheits-Eigenschaften und Approximationsgüte sicher beherrschen und die Fähigkeit zum aktiven Umgang mit den Gegenständen der Lehrveranstaltung erwerben und aufbauend auf diesen methodischen Werkzeugen erste grundlegende Konzepte für das approximative Lösen wissenschaftlicher und technischer Probleme aneignen.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Kenntnisse der Module Analysis I, Lineare Algebra I, Numerische Analysis I
References	W. Dahmen, A. Reusken, Numerik für Ingenieure und Naturwissenschaftler, Springer 2006; P. Deuflhard, A. Hohmann, Numerische Mathematik I, de Gruyter 2002; A. Reusken, Numerische Analysis II (Skript)
Language	German
Examination Terms	Zulassungsvoraussetzung: Lösen von Übungsaufgaben Prüfungsleistung: Bestehen einer Klausur oder mündlichen Prüfung; Prüfungsdauer und -art werden am Anfang des Semesters bekannt gegeben
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. rer. nat. Sebastian Noelle Universitätsprofessor Dr. rer. nat. Arnold Reusken
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	0

– Applied Courses
– Mathematics
+ Numerical Analysis II (1114981)

Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Numerical Analysis (111498102)	4th semester	no semester recommended	0	2
Exam Numerical Analysis II (111498101)	4th semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Numerical Analysis II	4th semester	no semester recommended	-	2

Module titel	Computeralgebra (Compulsory elective subject)
Identifier	1113549
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	irregularly
Valid from	Summer semester 2007
Valid until	-
Module level	Bachelor/Master
Content	Operation endlich erzeugter Gruppen auf Mengen, Homomorphiesatz für Gruppen, freie Gruppen, Homomorphiesatz für Ringe und Moduln, Teilbarkeitstheorie und Faktorisierungsalgorithmen, insbesondere endliche Körper und p-adische Zahlen, konstruktive Behandlung von endlich erzeugten Moduln über Polynomalgebren: Rechnen in Restklassenringen, Präsentationen von Moduln, Anwendungen auf algebraische Gleichungssysteme
Learning Objectives/ Learning Outcomes	Die Studierenden sollen Verständnis für Homomorphiekonzepte am Beispiel grundlegender algebraischer Strukturen entwickeln, algebraische Begriffsbildungen zusammen mit algorithmischen Konzepten einüben, formale Rechenmethoden und ihre Anwendbarkeit kennenlernen, strukturelles und algorithmisches Denken in grundlegenden Situationen verinnerlichen, diverse Computeralgebrasysteme benutzen sowie Basiswissen und Fertigkeiten für das weitere Studium erwerben.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	-
References	M. Artin: Algebra, Birkhäuser 1993; S. Lang: Algebra (third edition), Addison Wesley 1995; W.W. Adams, P. Loustaunau: An Introduction to Gröbner Bases, AMS 1994; D.F. Holt et al.: Handbook Of Computational Group Theory, Chapman &; Hall 2005
Language	German
Examination Terms	Zulassungsvoraussetzung: Lösen von Übungsaufgaben Prüfungsleistung: Bestehen einer Klausur oder einer mündlichen Prüfung (benotet); Prüfungsdauer und -art werden zu Beginn der Lehrveranstaltung bekannt gegeben.
Miscellaneous	-
Module coordinator	Universitätsprofessorin Dr. rer. nat. Eva Zerz Universitätsprofessorin Dr. Alice Niemeyer
ECTS Credits	10
Contact time (WSH)	6
Examination duration (min)	0

+ Computeralgebra (1113549)

Total hours (h)	300,0
Contact hours (h)	90,0
Self-study hours (h)	210,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Computeralgebra (111354902)	6th semester	no semester recommended	0	2
Exam Computeralgebra (111354901)	6th semester	no semester recommended	10	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Computeralgebra	6th semester	no semester recommended	-	4
Global Exercise Computeralgebra	6th semester	no semester recommended	-	-

Module titel	Complex Analysis I (Compulsory elective subject)
Identifier	1113550
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	irregularly
Valid from	Summer semester 2017
Valid until	-
Module level	Bachelor/Master
Content	Komplexe Differenzierbarkeit und Cauchy-Riemannsche Differentialgleichungen, Kurvenintegrale, Cauchysche Theorie, Abbildungsverhalten holomorpher Funktionen, einfach zusammenhängende Gebiete, isolierte Singularitäten, Residuensatz mit Anwendungen auf reelle Integrale, Produktdarstellungen, Gamma-Funktion, Riemannscher Abbildungssatz.
Learning Objectives/ Learning Outcomes	Die Studierenden sollen die Grundzüge der komplexen Analysis beherrschen und ihre Bedeutung für die reelle Analysis kennenlernen.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	-
References	W. Fischer, I. Lieb: Funktionentheorie, Vieweg 2005; E. Freitag, W. Busam: Funktionentheorie, Springer-Verlag, Berlin 2000; A. Krieg: Funktionentheorie I, Skript, RWTH Aachen 2010; R. Remmert, G. Schumacher: Funktionentheorie, Springer-Verlag, Berlin 2002
Language	German
Examination Terms	Zulassungsvoraussetzung: Lösen von Übungsaufgaben Prüfungsleistung: Bestehen einer Klausur oder einer mündlichen Prüfung (benotet); Prüfungsdauer und -art werden zu Beginn der Lehrveranstaltung bekannt gegeben.
Miscellaneous	-
Module coordinator	Universitätsprofessor Dr. rer. nat. Hartmut Führ
ECTS Credits	10
Contact time (WSH)	6
Examination duration (min)	0
Total hours (h)	300,0
Contact hours (h)	90,0
Self-study hours (h)	210,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exercise Complex Analysis I (111355002)	6th semester	no semester recommended	0	2
Exam Complex Analysis I (111355001)	6th semester	no semester recommended	10	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Complex Analysis I	6th semester	no semester recommended	-	4

Module titel	Introduction to Anatomy (Compulsory elective subject)
Identifier	9010759
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Summer semester 2009
Valid until	-
Module level	Bachelor
Content	Systematische und topographische Anatomie des Kopfes, des zentralen Nervensystems und der Sinnesorgane. Im Rahmen des Präparationskurses (Praktikum) werden im einzelnen folgende Themen behandelt: • Bewegungsapparat: Knochen und Gelenke, Anatomische Ebenen; Grundlagen; Muskelfunktionen • Brustsitus: Herz-/ Gefäßsystem; Atmungsorgane • Bauchsitus: Verdauungssystem; Harn- und Geschlechtsorgane; Abwehrsystem Die aktive Teilnahme an allen drei Praktikumsterminen ist Voraussetzung zur Prüfungszulassung. Die Teilnahme an der begleitenden Vorlesung "Propädeutik der Organsysteme" ist freiwillig.
Learning Objectives/ Learning Outcomes	Diese Veranstaltung soll die Studierenden in Bau und Funktion der Organsysteme einführen. Dabei soll den Studierenden ein Einblick in die Wechselbeziehungen zwischen den einzelnen Organsystemen vermittelt werden. Klinisch relevante Strukturen und Funktionen werden nicht nur in der Theorie (Vorlesung), sondern auch durch typische, klinische Untersuchungsmethoden (z.B. bildgebende Verfahren) demonstriert.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Keine
References	wird in der Veranstaltung bekannt gegeben
Language	German
Examination Terms	Die Benotung ergibt sich zu 100% aus der abschließenden Prüfung zum Modul, die in schriftlicher oder mündlicher Form erfolgt. Die endgültige Form der Prüfung wird zu Beginn der Veranstaltung bekanntgegeben. Wird vorgesehen, dass semesterbegleitende Hausaufgaben auf die Prüfungsnote angerechnet werden, sind die entsprechenden Regelungen der Prüfungsordnung zu beachten.
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Dr. rer. medic. Marion GrandeModellierungsteamverantwortlicher: Vanessa Ziemons M. A.Modulverantworlicher: Universitätsprofessor Dr. rer. nat. Thomas PufeUniversitätsprofessor Dr. med. Rudolf LeubeUniversitätsprofessor Dr. med. Andreas Lückhoff
ECTS Credits	4
Contact time (WSH)	2
Examination duration (min)	0

Total hours (h)	120,0
Contact hours (h)	30,0
Self-study hours (h)	90,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Introduction to Anatomy (901075901)	3rd semester	no semester recommended	4	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Practical Course Introduction to Anatomy	3rd semester	no semester recommended	-	2

Module titel	Medical Methodology (Compulsory elective subject)
Identifier	9010776
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2007
Valid until	-
Module level	Bachelor
Content	Ärztliches Arbeitsschritte: - Anamnese, Befunderhebung - Generierung von Primärhypothesen - Symptomatologische Differentialdiagnose - Nosologische Differentialdiagnose - Therapieplanung - Therapiemanagement - Dokumentation Organisatorischer Kontext: - Typologie - Organisation und Leistungsspektrum von Krankenhäusern - Akteure - Medizinische Spezialitäten - Gesundheitsökonomische Rahmenbedingungen ärztlichen Handelns - Methoden des Medizin-Controllings und der klinischen Qualitätssicherung Klinische Workflows: - Informelle Vorgehensweisen - Leitlinien - Klinische Behandlungspfade - Eskalationsszenarien Patientendaten: - Dokumentationsstandards und Terminologiesysteme - Dokumentationspflichten - Datenschutzmaßnahmen Klinisches Wissen: - Entwicklung und Kennzeichen klinischer Expertise - Explizite Dokumentation medizinischen Wissens - Repräsentationsformate für Medizinisches Wissen

Learning Objectives/ Learning Outcomes	Orientierungswissen zum ärztlichen Vorgehen, zum Kontext medizinischen Handelns (zeitliche, organisatorische, juristische und ökonomische Vorgaben bzw. Restriktionen) sowie zu den charakteristischen Besonderheiten klinischer Entscheidungsfindung und medizinischen Wissens. Die Studierenden lernen, medizinspezifische Herausforderungen an typischen Szenarien zu identifizieren und auf eigene (z.B. informationstechnische) Projekte zu beziehen. Spätere Kommunikations- und Orientierungsschwierigkeiten von Naturwissenschaftlern und der medizinischen Domäne werden reduziert.
(Study-Specific) Prerequisites	keine
(recommended) Requirements	Keine
References	-
Language	German
Examination Terms	Bestehen einer Klausur oder mündlichen Prüfung; Prüfungsdauer und -art werden am Anfang des Semesters bekannt gegeben
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Dr. rer. medic. Marion GrandeModellierungsteamverantwortlicher: Vanessa Ziemons M. A.Modulverantworlicher: Universitätsprofessor Dr. med. Dr. rer. nat. Klaus Kabino
ECTS Credits	2
Contact time (WSH)	2
Examination duration (min)	0
Total hours (h)	60,0
Contact hours (h)	30,0
Self-study hours (h)	30,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Medical Methodology (901077601)	3rd semester	no semester recommended	2	0

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Medical Methodology	3rd semester	no semester recommended	-	2

Module titel	Health Care Systems (Compulsory elective subject)
Identifier	9010777
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Summer semester 2009
Valid until	-
Module level	Bachelor
Content	Gesundheitssystem: - Geschichte - Rechtliche Grundlagen - Aufbau und Finanzierung - Selbstverwaltung (Beteiligte und Rollen) - Sozialversicherungssystem (Krankenversicherung, Rentenversicherung, Unfallversicherung, Pflegeversicherung, Arbeitslosenversicherung) - Vergütungssysteme, Abrechnungssysteme -Gesundheitspolitik - Rolle weiterer Beteiligter (z.B. Pharmaindustrie, Hersteller von Medizintechnik und Informationstechnologie) - Relevanz und Umsetzung von Dokumentation und Kommunikation - Kurative und präventive Medizin - Der Patient und Bürger im Gesundheitssystem - Gesundheitssysteme im internationalen Vergleich Das Krankenhaus als Organisation – Aspekte der Betriebswirtschaft und des Qualitätsmanagements in der Gesundheitsversorgung: - Strategisches Management - Taktisches Management - Controlling - Prozesskostenkalkulation und –rechnung - Personalwirtschaft - Qualitätsmanagement in der Medizin - Projektmanagement
Learning Objectives/ Learning Outcomes	Die Studierenden sollen den Aufbau des deutschen Gesundheitssystems, seine rechtlichen und ökonomischen Grundlagen, die Beteiligung und die Grundzüge der Finanzierung sowie aktuelle Problemstellungen der Finanzierung, Dokumentation und Kommunikation kennen. Die Studierenden sollen Grundzüge der Betriebswirtschaftslehre im Gesundheitswesen am Beispiel des Krankenhauses kennen lernen. Die Studierenden sollen mit dem strukturellen und organisatorischen Aufbau eines Krankenhauses sowie mit internen und externen Kundenbeziehungen vertraut sein.
(Study-Specific) Prerequisites	keine
(recommended) Requirements	Keine
References	-
Language	German
Examination Terms	Bestehen einer Klausur oder mündlichen Prüfung; Prüfungsdauer und -art werden am Anfang des Semesters bekannt gegeben

Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Dr. rer. medic. Marion GrandeModellierungsteamverantwortlicher: Vanessa Ziemons M. A.Modulverantworlicher: Universitätsprofessor Dr. med. Dr. rer. nat. Klaus Kabino
ECTS Credits	2
Contact time (WSH)	2
Examination duration (min)	0
Total hours (h)	60,0
Contact hours (h)	30,0
Self-study hours (h)	30,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Health Care Systems (901077701)	5th semester	no semester recommended	2	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Health Care Systems	5th semester	no semester recommended	-	2

Module titel	Medical Biometrics and Clinical Epidemiology (Compulsory elective subject)
Identifier	9010731
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2008
Valid until	-
Module level	Bachelor
Content	• • Guidelines und Studiendesigns • Bias in klinischen Studien • Anwendung biostatistischer Methoden in der medizinischen Diagnostik • Quantifizieren von Therapieeffekten (Konfidenzintervalle) • Beschreibung und Bewertung von Therapieunterschieden (Statistische Tests) • Varianzanalytische Verfahren • Übereinstimmung von Messmethoden • Umsetzung der Methoden der medizinischen Statistik mit Hilfe einer Statistiksoftware
Learning Objectives/ Learning Outcomes	Die Studierenden sollen Kenntnis und Verständnis der Grundlagen für die Anwendung und Umsetzung statistischer Methoden im klinischen Umfeld erwerben.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Keine
References	Hilgers, R.-D.; Bauer, P.; Scheiber, V.: Einführung in die Medizinische Statistik. Berlin [u.a]: Springer 2007.
Language	English
Examination Terms	Prüfungsleistung: Präsentation und Hausarbeit; Zulassungsvoraussetzung: Bestehen des Testats
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Dr. rer. medic. Marion GrandeModellierungsteamverantwortlicher: Vanessa Ziemons M. A.Modulverantworlicher: Universitätsprofessor Dr. rer. nat. Ralf-Dieter Hilgers
ECTS Credits	4
Contact time (WSH)	3
Examination duration (min)	0
Total hours (h)	120,0
Contact hours (h)	45,0
Self-study hours (h)	75,0

Medical Biometrics and Clinical Epidemiology (9010731)

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Medical Biometrics and Clinical Epidemiology (901073101)	5th semester	no semester recommended	4	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Medical Biometrics and Clinical Epidemiology	5th semester	no semester recommended	-	1
Exercise Medical Biometrics and Clinical Epidemiology	5th semester	no semester recommended	-	2

RWTH AACHEN UNIVERSITY

Module titel	Fundamentals of Biochemistry (Compulsory elective subject)
Identifier	9017752
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2017
Valid until	-
Module level	Bachelor
Content	- Grundzüge der chemischen Abläufe in lebenden Organismen - Struktur und Funktion von Proteinen und Nukleinsäuren
Learning Objectives/ Learning Outcomes	Vermittlung der Grundlagen für das Verständnis medizinischer Zusammenhänge und eines ersten Eindrucks modernen biochemischen Arbeitens.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	Keine
References	- Streyer, Biochemie - Lehninger, Biochemie - Löffler, Biochemie u. Pathobiochemie
Language	German
Examination Terms	schriftliche Prüfung; Prüfungsdauer wird am Anfang des Semesters bekannt gegeben
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Dr. rer. medic. Marion GrandeModellierungsteamverantwortlicher: Dipl.-Betriebsw. Tuuli SolomModulverantworlicher: Universitätsprofessor Dr. rer. nat. Bernhard LüscherDr. rer. nat. Peter Krüger
ECTS Credits	2
Contact time (WSH)	1
Examination duration (min)	0
Total hours (h)	60,0
Contact hours (h)	15,0
Self-study hours (h)	45,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Fundamentals of Biochemistry (901775201)	3rd semester	no semester recommended	2	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Fundamentals of Biochemistry	3rd semester	no semester recommended	-	1

Module titel	Medical Software Engineering (Compulsory elective subject)
Identifier	4011672
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Summer semester 2014
Valid until	-
Module level	Master
Content	Vermittelt werden die gesetzlichen Anforderungen an die Softwareentwicklung in der Medizintechnik, welche an praktischen Beispielen in den Übungen umgesetzt werden. Dabei werden alle Teile des Software-Lebenszyklus von der Anforderungsanalyse über das Software-Design bis hin zur Implementierung und Verifikation behandelt. Ein weiterer Schwerpunkt liegt in Methoden der Risikoanalyse und -Beherrschung.
Learning Objectives/ Learning Outcomes	Wissen und Verstehen: die Studierenden kennen im Bereich der Softwareentwicklung in der Medizintechnik - gängige Anwendungsfelder - mögliche Entwicklungsprozesse - aktuelle gesetzliche Anforderungen - Risiken, die von der Software und dem verwendeten Softwareentwicklungsprozess ausgehen können - Methoden zur Risikobewertung und zur Risikobeherrschung Fertigkeiten und Kompetenzen: Die Studierenden besitzen ein Verständnis für die Risiken, die von dem Softwareentwicklungsprozess ausgehen und beherrschen Methoden, die Risiken zu analysieren und zu minimieren. Sie sind in der Lage, einen geeigneten Entwicklungsprozess für den gesamten Lebenszyklus der Software anzuwenden. Die Studierenden sind in der Lage, die Software zu entwerfen, in C++ zu implementieren und dabei Methoden der Risikoanalyse (FMEA/FTA) und des Qualitätsmanagements (u.a. SVN) anzuwenden.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Empfohlene Voraussetzungen: Kentnisse in Objektorientiertem Softwaredesign Erfahrungen in einer objektorientierten Programmiersprache (JAVA, C/C++, C#,...)
References	Folien zur Vorlesung und Übungsblätter Empfohlene weiterführende Literatur: Normen:IEC 62304 W. Niederlag, H.U. Lemke, G. Strauss, H. Feussner: Der digitale Operationssaal. 2.Auflage, De Gruyter Verlag 2014
Language	German
Examination Terms	Die Endote ergibt sich aus der Benotung der Projektarbeit (70%) und des Kolloquiums (30%).
Miscellaneous	-

– Applied Courses
– Medicine
– Application Subject Medicine
+ Medical Software Engineering (4011672)

Module coordinator	Dr.-Ing. Matías de la Fuente Klein
ECTS Credits	4
Contact time (WSH)	3
Examination duration (min)	-
Total hours (h)	120,0
Contact hours (h)	45,0
Self-study hours (h)	75,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Medical Software Engineering (40116721)	3rd semester	no semester recommended	4	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Übung (Praktikum) Softwareentwicklung in der Medizintechnik	3rd semester	no semester recommended	-	2
Vorlesung Softwareentwicklung in der Medizintechnik	3rd semester	no semester recommended	-	1

Module titel	Clinical Studies (Compulsory elective subject)
Identifier	9010781
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Summer semester 2010
Valid until	-
Module level	Bachelor
Content	Die Lehrveranstaltung bietet eine Einführung in die Planung, Durchführung und Auswertung Klinischer Studien, wobei nicht nur auf medizin-statistische, sondern auch auf ethische, organisatorische und administrative Fragen eingegangen wird. Die folgenden Themen werden besprochen: - Einführung, Historisches, Richtlinien - Studienplanung und Durchführung - Randomisierung und Blindbedingungen - Statistische Aspekte der Versuchsanlagen und Datenauswertung - Cross-Over Versuchsanlagen - Multizenterstudien - Überlebenszeitanalysen - Fallzahlplanung - Berichterstellung - Metaanalysen-EBM
Learning Objectives/ Learning Outcomes	-
(Study-Specific) Prerequisites	-
(recommended) Requirements	Keine
References	Friedman, L. M., C. D. Furberg und D. L. deMets (1999). Fundamentals of Clinical Trials. Springer, Heidelberg.
Language	German
Examination Terms	Prüfungsleistung: Bestehen einer Klausur oder mündlichen Prüfung; Prüfungsdauer und -art werden am Anfang des Semesters bekannt gegeben
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Dr. rer. medic. Marion GrandeModellierungsteamverantwortlicher: Vanessa Ziemons M. A.Modulverantworlicher: Unbekannt

– Applied Courses
– Medicine
– Application Subject Medicine
+ Clinical Studies (9010781)

ECTS Credits	3
Contact time (WSH)	2
Examination duration (min)	0
Total hours (h)	90,0
Contact hours (h)	30,0
Self-study hours (h)	60,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Clinical Studies (901078101)	3rd semester	no semester recommended	3	0

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Clinical Studies	3rd semester	no semester recommended	-	2

Module titel	Electrophysiology and Measurement Technology (Compulsory elective subject)
Identifier	9010783
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2009
Valid until	-
Module level	Master
Content	• Introduction to biomedical engineering • Physical and physiological measurements • The resting potential of cells from a technical point of view. • The measurement of the resting potential. • The excitation of cells • The action potential from a technical point of view • The excitation spread • The electrical field at the cell membrane • The body as a volume conductor • Devices for the detection of biosignals • EMG-Signals and movement analysis • ECG-Signals • The cardiac pacemaker • EEG-Signals and evoked potentials • Safety requirements for electrical devices used in medical applications. • Practical demonstrations
Learning Objectives/ Learning Outcomes	• The students know and understand the principle physiological basics of cell's resting potential, excitation and excitation spread. • The students are able to explain the origin of biosignals based on the phenomena at the cell membrane. • The students have the ability to independently design a device / measurement system for the detection of biosignals. • The students know the safety requirements for electrical devices used in medical applications. • The students know the most frequent sources of error, how to reduce interferences and enhance signal quality. • The students are capable of realising test set-ups based on the theoretical knowledge learnt. • Through the lectures the students are qualified to transfer their specialised knowledge in mechanical engineering to other disciplines like electrical engineering or medicine. • Ince the lectures are interdisciplinary the students learn to think outside their major subject area.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Knowledge of an appropriate degree program with professional qualification
References	• Physiologiebücher • Hutten: Biomedizinische Technik
Language	German
Examination Terms	written examination (90min) or oral examination (30min)

Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Dr. rer. medic. Marion GrandeModellierungsteamverantwortlicher: Vanessa Ziemons M. A.Modulverantworlicher: Universitätsprofessorin Dr. rer. nat. Catherine Dißelhorst-Klug Ph. D.
ECTS Credits	2
Contact time (WSH)	3
Examination duration (min)	0
Total hours (h)	60,0
Contact hours (h)	45,0
Self-study hours (h)	15,0

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Electrophysiology and Measurement Technology (901078301)	5th semester	no semester recommended	2	0

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture and Exercise Electrophysiology and Measurement Technology	5th semester	no semester recommended	-	3

Module titel	Fundamentals of Biomaterials (Compulsory elective subject)
Identifier	9013677
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2007
Valid until	-
Module level	Master
Content	Werkstoffanwendungen in der Medizin; Anforderungen, Eigenschaften, Prüftechnik, Zuverlässigkeit und Wirtschaftlichkeit von Biowerkstoffen; Medizinische Terminologie; Vermarktungsaspekte von Biowerkstoffen
Learning Objectives/ Learning Outcomes	Wissen / Verstehen Die Studierenden verstehen die Grundlagen im Bereich der interdisziplinären Thematik der Biowerkstoffe. Anwenden / Analyse Ausgewählte Biowerkstoffe werden beispielhaft für ihren Einsatz im Bereich Prothetik und Implantologie behan-delt. Synthese / Beurteilen Die Studierenden können auf der Grundlage ihres Basiswissens Werkstoffe, welche vornehmlich für medizinische Prothesen und Implantate eingesetzt werden, auswählen und ihren Einsatz analysieren sowie kritisch bewerten.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Keine
References	-
Language	German
Examination Terms	Mündliche Prüfung
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Dr. rer. medic. Marion GrandeModellierungsteamverantwortlicher: Vanessa Ziemons M. A.Modulverantworlicher: Universitätsprofessor Dr.-Ing. Horst Fischer
ECTS Credits	3
Contact time (WSH)	2
Examination duration (min)	0
Total hours (h)	90,0
Contact hours (h)	30,0
Self-study hours (h)	60,0

– Applied Courses
– Medicine
– Application Subject Medicine
+ Fundamentals of Biomaterials (9013677)

● Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Fundamentals of Biomaterials (901367701)	3rd semester	no semester recommended	3	0

▲ Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Fundamentals of Biomaterials	3rd semester	no semester recommended	-	2

Module titel	Sample Size Estimation (Compulsory elective subject)
Identifier	9013716
Version	Angelegt über RWTH API als 1
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2009
Valid until	-
Module level	Master
Content	Die Anzahl der Patienten, die beispielsweise im Rahmen einer klinischen Studie rekrutiert werden sollen – auch Fallzahl oder Stichprobenumfang genannt – stellt eine entscheidende Grundlage für die Aussagekraft der geplanten Studie dar. Die Fallzahl sollte vor Beginn einer Studie begründet und verbindlich im Studienprotokoll festgehalten werden. Das Tutorium zur Fallzahlplanung bietet eine Einführung in die statistischen Methoden zur Bestimmung des Stichprobenumfangs in speziellen Studienszenarien, wie etwa der Vergleich von zwei Anteilen oder Mittelwerten in unabhängigen Stichproben. Darüber hinaus wird der Einfluss spezieller Aspekte wie der Einfluss der Drop-out Rate und von Verfahren zu Interimsanalysen diskutiert. Von zentraler Bedeutung ist dabei die Größenordnung des nachzuweisenden Effektes, i.e. Effektmaß.
Learning Objectives/ Learning Outcomes	Die Studierenden sollen Verständnis für die Problematik der Fallzahlschätzung anhand verschiedener statistischer Verfahren entwickeln und die entsprechenden Verfahren anwenden können.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Keine
References	Wird in der Vorlesung bekannt gegeben.
Language	German
Examination Terms	Prüfungsleistung: Regelmäßige Teilnahme; Bestehen einer Klausur oder einer mündlichen Prüfung; Prüfungsdauer und -art werden am Anfang des Semesters bekannt gegeben
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Dr. rer. medic. Marion GrandeModellierungsteamverantwortlicher: Vanessa Ziemons M. A.Modulverantworlicher: Universitätsprofessor Dr. rer. nat. Ralf-Dieter Hilgers
ECTS Credits	2
Contact time (WSH)	2
Examination duration (min)	0
Total hours (h)	60,0
Contact hours (h)	30,0

Self-study hours (h)	30,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Master Thesis Sample Size Estimation (901371601)	5th semester	no semester recommended	2	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Tutorium Fallzahlplanung	5th semester	no semester recommended	-	2

Module titel	Introduction to Medicine for Nature Scientists and Engineers 1 and 2 (Compulsory elective subject)
Identifier	9010782
Version	Angelegt über RWTH API als 1
Duration (Semester)	two semesters
Cycle (Semester)	winter semester
Valid from	Summer semester 2008
Valid until	-
Module level	Master
Content	Introduction to Medicine for Nature Scientists and Engineers 1 • Cell biology: structure of cells and cell membranes; transport processes; definition and calculation of membrane potentials. • Neurophysiology: characteristics of action potentials; properties of axonal information propagation and coding; types and working schemes of synaptic connections. • Anatomy: axes, planes and directions of the coordinate system “patient”; types and characteristics of joints and associated tissues. • Musculature: different muscle types; macroscopic and microscopic structure of a skeletal muscle; electro-mechanic coupling; force-length-diagram of the skeletal muscle. • Circulatory system: circulatory systems of lung and body; distribution of flow and volumes; blood pressure and basics of blood rheology. • Heart: anatomy (position and construction) of the heart; tomographic planes; atria, chambers and valves; connection to the circulatory system; pressure-volume diagram; pace-setter tissues, clinical applications. • Blood: different types of blood cells; their morphology and function; blood test results; blood types AB0 and Rh; mechanisms of primary and secondary haemostasis. Introduction to Medicine for Nature Scientists and Engineers 2 • Respiration: anatomy (position and construction) of the lung; lung physiology; diffusion processes; measurement of the lung function; influence of respiration on blood-pH. • Renal physiology: anatomy (position and construction) of the kidneys; kidney physiology; mechanisms of substrate concentration; measurement of the renal function. • Digestion: anatomy (position and construction) of the different parts of the digestive system; path of a nutrient pre- and during digestion. • Senses: definition of the sensory systems; mathematical characterisation of sensor cells; construction and duties of the skin, the eye, the inner ear, the tongue, and the nose; pain. • Medical psychology: planning, performing and evaluating experiments; social perception; learning theories and processes; observation and monitoring of processes; typical failures thereof. • CNS: anatomy (position and construction) of the different parts of the central nervous system; experimental methods for neural measurements; simple neural circuits. • Dissection room demonstration: cadaver preparation; advantages of learning in an dissection room; demonstration of selected organs and tissues.
Learning Objectives/ Learning Outcomes	Introduction to Medicine for Nature Scientists and Engineers 1 Subject-related learning targets: Students achieve a basic understanding of structures, functions and processes in the living human body. They know about construction and hierarchies on the levels of proteins, cells and organs. They are able to reproduce characteristic values and name consequences that arise when deviations of these values occur. Cause-response schemes of the most important control cycles can be characterized. Students can adapt these basic principles to different fields of engineering and life sciences. They can rate medical textbooks and medical communications. Interdisciplinary learning targets: Students gain basic competences in communications skills with members of life sciences professions.

	Introduction to Medicine for Nature Scientists and Engineers 2 Subject-related learning targets: Students achieve a higher understanding of structures, functions and processes in the living human body. They know about construction and hierarchies on the levels of organs and organ systems. They are able to comment on a physician’s work in his roles of helpinp people and doing science. Cause-response schemes of more specialised control cycles can be characterized. Students can further adapt these basic principles to different fields of engineering and life sciences. They can rate medical textbooks and medical communications. Interdisciplinary learning targets: Students gain advanced competences in communications skills with members of life sciences professions.
(Study-Specific) Prerequisites	-
(recommended) Requirements	Introduction to Medicine for Nature Scientists and Engineers 1 Basic knowledge from life sciences, physics, electric engineering and mechanics. Willingness to adopt interdisciplinary conversation and thinking schemes.
References	• Speckmann, Erwin-Josef; Wittkowski, Werner, „Bau und Funktion des menschlichen Körpers. Praxisorientierte Anatomie und Physiologie“, 20., völlig neu bearb. Aufl, Urban &; Fischer, München, 2004. • Schwegler, Johann, „Der Mensch. Anatomie und Physiologie; Schritt für Schritt Zusammenhänge verstehen“, 4., überarb. Aufl, Thieme, Stuttgart, 2006. • Kugler, Peter, „Zelle, Organ, Mensch. Bau, Funktion und Krankheiten“, 1. Aufl, Elsevier, Urban &; Fischer, München, 2006. • Spornitz, Udo M., „Anatomie und Physiologie. Lehrbuch und Atlas für Pflege- und Gesundheitsfachberufe“, 4., vollst. überarb. Aufl, Springer Medizin; Heidelberg, 2004.
Language	German
Examination Terms	Oral Exam (30 min) or written Exam (90 min). Participation in the parallel running practical MINP1. Introduction to Medicine for Nature Scientists and Engineers 1
Miscellaneous	-
Module coordinator	Modulangebotsorganisator: Dr. rer. medic. Marion GrandeModellierungsteamverantwortlicher: Vanessa Ziemons M. A.Modulverantworlicher: apl. Professor Dr.rer.nat. Dipl.-Ing. Martin Baumann MME
ECTS Credits	6
Contact time (WSH)	4
Examination duration (min)	0
Total hours (h)	180,0
Contact hours (h)	60,0
Self-study hours (h)	120,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Introduction to Medicine for Nature Scientists and Engineers 1 and 2 (901078201)	3rd semester	no semester recommended	6	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture and Exercise Introduction to Medicine for Nature Scientists and Engineers 1 and 2	3rd semester	no semester recommended	-	4

Module titel	Cognitive Psychology (Compulsory elective subject)
Identifier	7021320
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Winter semester 2019
Valid until	-
Module level	Bachelor
Content	This lecture will provide students with an introduction to the field of cognitive psycholo-gy. Cognitive psychology is a subfield of the science of psychology that focuses on mental processes such as attention, language use, memory, perception, problem solv-ing, creativity, and thinking. This lecture will give you a broad overview of the major theories and concepts and corresponding findings within cognitive psychology. Specific Contents: • Introduction to cognitive psychology • Perception (Sensory Systems & Psychophysics) • Perceptual organization • Attention (Selective Attention, Divided Attention, Visual Attention) • Memory (Models, Functions, and Mechanisms) • Learning • Emotion and Motivation • Reasoning & Problem Solving • Cognitive Development
Learning Objectives/ Learning Outcomes	Learning objectives for this course include acquiring a deep understanding of core con-cepts of human cognition, and appreciating the scientific process whereby real -world issues are investigated through controlled laboratory experimentation. Students will be able to demonstrate knowledge in selected content areas, describe the main findings in the primary areas of scientific research within cognitive psychology, and compare and contrast the theories associated within the primary areas of scientific research in cogni-tive psychology (e.g., models of memory, attention, etc.).
(Study-Specific) Prerequisites	None.
(recommended) Requirements	-
References	• Eysenck, M. W., & Kean, M. T. (2015). Cognitive Psychology: A Student's Handbook. Taylor & Francis Ltd.; 7th ed • Goldstein, E. (2010). Cognitive Psychology. Cengage Learning, Inc; • Goldstein, E. B. (2014). Wahrnehmungspsychologie. Der Grundkurs. Berlin: Springer
Language	English
Examination Terms	The grading results from 100% of the final exam of this module. The exam can be a written or an oral exam. The final form of the examination is announced at the beginning of the lecture.
Miscellaneous	-
Module coordinator	• Modulangebotsorganisation: LeMa-Team Philosophische Fakultät, modulangebotsorganisation@fb7.rwth-aachen.de • Modulverantwortliche: Univ.-Prof. Dr. rer. nat. Astrid Rosenthal-von der Pütten
ECTS Credits	4
Contact time (WSH)	2
Examination duration (min)	60

+ Cognitive Psychology (7021320)

Total hours (h)	120,0
Contact hours (h)	30,0
Self-study hours (h)	90,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Cognitive Psycholo-gy (702132001)	6th semester	no semester recommended	4	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Cognitive Psycho-logy	6th semester	no semester recommended	-	2

Module titel	Media Psychology (Compulsory elective subject)
Identifier	7021321
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	summer semester
Valid from	Winter semester 2019
Valid until	-
Module level	Bachelor
Content	Media psychology is the subfield of psychology that focuses on the interaction of hu-man behavior and media and technology. Media psychology includes all forms of me-diated communication and media technology-related behaviors. This lecture is closely linked to the module social psychology because it explains human perception and be-havior in the social context of media and technology. Specific Contents: • History of media psychology • Motives (uses and gratification, selective exposure, mood management) • Cognition (attention and information processing, reception modalities, cognitive media effects) • Emotion (involvement, suspense, entertainment, sad film paradox) • Communication (para-social interaction, social comparison, Schweigespirale, media equation) • Behavior (violence, prosocial behavior, internet addiction)
Learning Objectives/ Learning Outcomes	Goal of this module is to enable students to recognize, explain and evaluate the relations between the different subfields of psychology and the topic area or media and technology (e.g., the relation between social psychology topic aggression and phe-nomenon of media violence). Students will be able to demonstrate knowledge in se-lected content areas, describe the main findings in the primary areas of scientific re-search within media psychology, and apply this knowledge to job profiles in new media businesses.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	-
References	-
Language	English
Examination Terms	The grading results from 100% of the final exam of this module. The exam can be a written or an oral exam. The final form of the examination is announced at the beginning of the lecture.
Miscellaneous	-
Module coordinator	• Modulangebotsorganisation: LeMa-Team Philosophische Fakultät, modulangebotsorganisation@fb7.rwth-aachen.de • Modulverantwortliche: Univ.-Prof. Dr. rer. nat. Astrid Rosenthal-von der Pütten
ECTS Credits	4
Contact time (WSH)	2

– Applied Courses
– Psychology
+ Media Psychology (7021321)

Examination duration (min)	60
Total hours (h)	120,0
Contact hours (h)	30,0
Self-study hours (h)	90,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Media Psychology (702132101)	5th semester	no semester recommended	4	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Media Psychology	5th semester	no semester recommended	-	2

RWTH AACHEN UNIVERSITY

Module titel	Communication Psychology (Compulsory elective subject)
Identifier	7021319
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2019
Valid until	-
Module level	Bachelor
Content	Communication psychology is the subfield of psychology that focuses on phenomena of human verbal and nonverbal communication. This lecture focuses on the construc-tion of reality from a communication theory perspective. It relates to media psychology with regard to contents on mediated communication and media technology-related communication behaviors. Specific Contents: • Terminology and definition • Basic theories on human communication from ethological, sociological and psy-chological perspectives • Communication as social construction of reality, system-theory approaches to explain communication • Verbal communication • Nonverbal communication • Gender-specific communication • Computer-mediated communication • Methods in communication research
Learning Objectives/ Learning Outcomes	Goal of this module is to enable students to define, describe and evaluate the different theoretical approaches to the phenomena of human communication. Students will be able to demonstrate knowledge in selected content areas, describe the main findings in the primary areas of scientific research within communication psychology, and transfer this knowledge about human communication to application fields such as organizational communication or human-computer interaction.
(Study-Specific) Prerequisites	None.
(recommended) Requirements	-
References	-
Language	English
Examination Terms	The grading results from 100% of the final exam of this module. The exam can be a written or an oral exam. The final form of the examination is announced at the beginning of the lecture.
Miscellaneous	-
Module coordinator	• Modulangebotsorganisation: LeMa-Team Philosophische Fakultät, modulangebotsorganisation@fb7.rwth-aachen.de • Modulverantwortliche: Univ.-Prof. Dr. rer. nat. Astrid Rosenthal-von der Pütten
ECTS Credits	4
Contact time (WSH)	2

Communication Psychology (7021319)

Examination duration (min)	60
Total hours (h)	120,0
Contact hours (h)	30,0
Self-study hours (h)	90,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Communication Psychology (702131901)	6th semester	no semester recommended	4	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Communication Psychology	6th semester	no semester recommended	-	2

Module titel	Social Psychology (Compulsory elective subject)
Identifier	7021318
Version	V1
Duration (Semester)	one semester
Cycle (Semester)	winter semester
Valid from	Winter semester 2019
Valid until	-
Module level	Bachelor
Content	This lecture will provide students with an introduction to the field of social psychology. Social psychology is a subfield of the science of psychology that focuses on the per-ceptions, thoughts, feelings, and behaviors of individuals and groups within a social context. This lecture will give you a broad overview of the major theories and concepts and corresponding findings within social psychology. Specific Contents: • History and methods in social psychology • Person perception • Stereotypes • Attitudes and persuasion • Self-concept • Conflict and aggression • Social influence and conformity • Prosocial behavior • Interpersonal attraction • Behavior in groups
Learning Objectives/ Learning Outcomes	Goal of this module is to enable students to understand observations and events in their daily interactions as social phenomena and explain these phenomena by using theories and concepts from social psychology. Students will be able to establish relationships to questions in other disciplines such as business science, pedagogy, communication science, and sociology. After the course students will 1) have gained knowledge of the major theories and current findings in social psychology, 2) have gained knowledge on the scientific method underlying social psychology research, 3) be able to recognize and appreciate how theory and experimental findings apply to everyday situations.
(Study-Specific) Prerequisites	-
(recommended) Requirements	-
References	English: Aronson, E., Wilson, T. D., & Akert, R. M. (2005). Social psychology (pp. 324-25). Upper Saddle River, NJ: Prentice Hall. German: Aronson, E., Akert, R. M., & Wilson, T. D. (2010). Sozialpsychologie. Pearson Deutschland GmbH.
Language	English
Examination Terms	The grading results from 100% of the final exam of this module. The exam can be a written or an oral exam. The final form of the examination is announced at the beginning of the lecture.
Miscellaneous	-
Module coordinator	• Modulangebotsorganisation: LeMa-Team Philosophische Fakultät, modulangebotsorganisation@fb7.rwth-aachen.de

– Applied Courses
– Psychology
+ Social Psychology (7021318)

	• Modulverantwortliche: Univ.-Prof. Dr. rer. nat. Astrid Rosenthal-von der Pütten
ECTS Credits	4
Contact time (WSH)	2
Examination duration (min)	60
Total hours (h)	120,0
Contact hours (h)	30,0
Self-study hours (h)	90,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Exam Social Psychology (702131801)	5th semester	no semester recommended	4	0

Offer node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Lecture Social Psychology	5th semester	no semester recommended	-	2

RWTH AACHEN UNIVERSITY

+ Bachelor Thesis (1215682)

Module titel	Bachelor Thesis (Compulsory subject)
Identifier	1215682
Version	v2
Duration (Semester)	one semester
Cycle (Semester)	winter/summer semester
Valid from	Winter semester 2024
Valid until	-
Module level	Bachelor
Content	For the Bachelor's project, a science-oriented topic on concepts, practices and results of computer science will be agreed on with the supervisor. The topic can be theoretically or practically oriented, in each case, in any case, a critical analysis and evaluation is required. Examples include: Literature review and assessment of existing approaches on a current scientific topic, in-depth assessment and analytical or empirical comparison of selected solution statements. Implementation, development and evaluation of existing methods and concepts of computer science for scientific analysis (evaluation of prototype), or for educational use (prototype demonstration), evaluating the performance of systems in relation to specific tasks and work loads. Topics may be treated collectively, but must result, in consultation with the supervisor, in distinct and individual in-depth performances.
Learning Objectives/ Learning Outcomes	Acquisition of the following skills to independently develop a scientific theme of computer science: Ability to familiar oneself with the topic, to categorize it, to narrow it down, to evaluate it critically, and to further develop it. Ability to treat the topic clearly and formal adequate in writing meeting a specific length. Ability to treat the topic professionally and descriptive in an oral presentation of given length. Ability to actively contribute to discussions on science-oriented topics of computer science.
(Study-Specific) Prerequisites	See examination regulations.
(recommended) Requirements	For the admission to the Bachelor's project, a minimum of 120 ECTS from the modules of previous semesters are required. For concrete topics varying prior knowledge is required, which is determined by the corresponding thesis supervisor.
References	Themenabhängig; wird vorgegeben bzw.selbst recherchiert
Language	German
Examination Terms	The module examination consists of the following components: Written thesis (12 CP) and colloquium (3 CP).
Miscellaneous	-
Module coordinator	-
ECTS Credits	15
Contact time (WSH)	0
Examination duration (min)	-
Total hours (h)	450,0

RWTH AACHEN UNIVERSITY

+ Bachelor Thesis (1215682)

Contact hours (h)	,0
Self-study hours (h)	450,0

Exam node

Title	Recommended Semester (Study start winter)	Recommended Semester (Study start summer)	ECTS Credits	Contact time (WSH)
Bachelor Thesis (121568201)	6th semester	no semester recommended	15	0