TUHH

Technische Universität Hamburg-Harburg

Module Manual

Bachelor of Science

Computational Science and Engineering

Cohort: Winter Term 2017

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Table of Contents

Program description

Content

Core qualification

Module M0561: Discrete Algebraic Structures

Courses

Title	Typ	Hrs/wk	CP
Discrete Algebraic Structures (L0164)	Lecture	2	3
Discrete Algebraic Structures (L0165)	Recitation Section (small)	2	3

Module Responsible	Prof. Karl-Heinz Zimmermann
Admission Requirements	None.
Recommended Previous Knowledge	Mathematics from High School.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students know the important basics of discrete algebraic structures including elementary combinatorial structures, monoids, groups, rings, fields, finite fields, and vector spaces. They also know specific structures like sub-. sum-, and quotient structures and homomorphisms.
Skills	Students are able to formalize and analyze basic discrete algebraic structures.
Personal Competence	
Social Competence	Students are able to solve specific problems alone or in a group and to present the results accordingly.
Autonomy	Students are able to acquire new knowledge from specific standard books and to associate the acquired knowledge to other classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory Computer Science: Core qualification: Compulsory General Engineering Science (English program): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory Computational Science and Engineering: Core qualification: Compulsory Technomathematics: Specialisation I. Mathematics: Elective Compulsory

Course L0164: Discrete Algebraic Structures

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Karl-Heinz Zimmermann
Language	DE
Cycle	WiSe
Content	
Literature	

Course L0165: Discrete Algebraic Structures

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

Module M0575: Procedural Programming

Courses

Title	Typ	Hrs/wk	CP
Procedural Programming (L0197)	Lecture	1	2
Procedural Programming (L0201)	Recitation Section (large)	1	1
Procedural Programming (L0202)	Laboratory Course	2	3

Module Responsible	Prof. Siegfried Rump
Admission Requirements	None
Recommended Previous Knowledge	Elementary PC handling skills Elementary mathematical skills
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students acquire the following knowledge: • They know basic elements of the programming language C. They know the basic data types and know how to use them. • They have an understanding of elementary compiler tasks, of the preprocessor and programming environment and know how those interact. • They know how to bind programs and how to include external libraries to enhance software packages. • They know how to use header files and how to declare function interfaces to create larger programming projects. • The acquire some knowledge how the program interacts with the operating system. This allows them to develop programs interacting with the programming environment as well. • They learnt several possibilities how to model and implement frequently occurring standard algorithms.
Skills	• The students know how to judge the complexity of an algorithms and how to program algorithms efficiently. • The students are able to model and implement algorithms for a number of standard functionalities. Moreover, they are able to adapt a given API.
Personal Competence	
Social Competence	The students acquire the following skills: • They are able to work in small teams to solve given weekly tasks, to identify and analyze programming errors and to present their results. • They are able to explain simple phenomena to each other directly at the PC. • They are able to plan and to work out a project in small teams. • They communicate final results and present programs to their tutor.
Autonomy	• The students take individual examinations as well as a final written examn to prove their programming skills and ability to solve new tasks. • The students have many possibilities to check their abilities when solving several given programming exercises. • In order to solve the given tasks efficiently, the students have to split those appropriately within their group, where every student solves his or her part individually.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Written exam
Examination duration and scale	90 minutes
Assignment for the Following Curricula	Computer Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Computational Science and Engineering: Core qualification: Compulsory Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory Mechatronics: Core qualification: Compulsory Technomathematics: Core qualification: Compulsory

Course L0197: Procedural Programming	
Typ	Lecture
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Siegfried Rump
Language	DE
Cycle	WiSe
Content	• basic data types (integers, floating point format, ASCII-characters) and their dependencies on the CPU architecture • advanced data types (pointers, arrays, strings, structs, lists) • operators (arithmetical operations, logical operations, bit operations) • control flow (choice, loops, jumps) • preprocessor directives (macros, conditional compilation, modular design) • functions (function definitions/interface, recursive functions, "call by value" versus "call by reference", function pointers) • essential standard libraries and functions (stdio.h, stdlib.h, math.h, string.h, time.h) • file concept, streams • basic algorithms (sorting functions, series expansion, uniformly distributed permutation) • exercise programs to deepen the programming skills
Literature	**Kernighan, Brian W** (Ritchie, Dennis M.;) The C programming language ISBN: 9780131103702 *Upper Saddle River, NJ [u.a.] : Prentice Hall PTR, 2009* **Sedgewick, Robert** Algorithms in C ISBN: 0201316633 *Reading, Mass. [u.a.] : Addison-Wesley, 2007* **Kaiser, Ulrich** (Kecher, Christoph.;) C/C++: Von den Grundlagen zur professionellen Programmierung ISBN: 9783898428392 *Bonn : Galileo Press, 2010* **Wolf, Jürgen** C von A bis Z : das umfassende Handbuch ISBN: 3836214113 *Bonn : Galileo Press, 2009*

Course L0201: Procedural Programming	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Siegfried Rump
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0202: Procedural Programming	
Typ	Laboratory Course
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Siegfried Rump
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0577: Nontechnical Complementary Courses for Bachelors

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

Autonomy	**Personal Competences (Self-reliance)** Students are able in selected areas • to reflect on their own profession and professionalism in the context of real-life fields of application • to organize themselves and their own learning processes • to reflect and decide questions in front of a broad education background • to communicate a nontechnical item in a competent way in writen form or verbaly • to organize themselves as an entrepreneurial subject country (as far as this study-focus would be chosen)
Workload in Hours	Depends on choice of courses
Credit points	6

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

Module M0743: Electrical Engineering I: Direct Current Networks and Electromagnetic Fields

Courses

Title	Typ	Hrs/wk	CP
Electrical Engineering I: Direct Current Networks and Electromagnetic Fields (L0675)	Lecture	3	5
Electrical Engineering I: Direct Current Networks and Electromagnetic Fields (L0676)	Recitation Section (small)	2	1

Module Responsible	Prof. Manfred Kasper
Admission Requirements	None
Recommended Previous Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	
Skills	
Personal Competence	
Social Competence	
Autonomy	
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Examination	Written exam
Examination duration and scale	zweistündig
Assignment for the Following Curricula	General Engineering Science (German program): Core qualification: Compulsory General Engineering Science (German program, 7 semester): Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Computational Science and Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory

Course L0675: Electrical Engineering I: Direct Current Networks and Electromagnetic Fields

Typ	Lecture
Hrs/wk	3
CP	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
Lecturer	Prof. Manfred Kasper
Language	DE
Cycle	WiSe
Content	
Literature	1. M. Kasper, Skript zur Vorlesung Elektrotechnik 1, 2013 2. M. Albach: Grundlagen der Elektrotechnik 1, Pearson Education, 2004 3. F. Moeller, H. Frohne, K.H. Löcherer, H. Müller: Grundlagen der Elektrotechnik, Teubner, 2005 4. A. R. Hambley: Electrical Engineering, Principles and Applications, Pearson Education, 2008

Course L0676: Electrical Engineering I: Direct Current Networks and Electromagnetic Fields

Typ	Recitation Section (small)
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Prof. Manfred Kasper
Language	DE
Cycle	WiSe
Content	
Literature	1. Übungsaufgaben zur Elektrotechnik 1, TUHH, 2013 2. Ch. Kautz: Tutorien zur Elektrotechnik, Pearson Studium, 2010

Module M0850: Mathematics I

Courses

Title	Typ	Hrs/wk	CP
Analysis I (L1010)	Lecture	2	2
Analysis I (L1012)	Recitation Section (small)	1	1
Analysis I (L1013)	Recitation Section (large)	1	1
Linear Algebra I (L0912)	Lecture	2	2
Linear Algebra I (L0913)	Recitation Section (small)	1	1
Linear Algebra I (L0914)	Recitation Section (large)	1	1

Module Responsible	Prof. Anusch Taraz
Admission Requirements	none
Recommended Previous Knowledge	School mathematics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students can name the basic concepts in analysis and linear algebra. They are able to explain them using appropriate examples. • Students can discuss logical connections between these concepts. They are capable of illustrating these connections with the help of examples. • They know proof strategies and can reproduce them.
Skills	• Students can model problems in analysis and linear algebra with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods. • Students are able to discover and verify further logical connections between the concepts studied in the course. • For a given problem, the students can develop and execute a suitable approach, and are able to critically evaluate the results.
Personal Competence	
Social Competence	• Students are able to work together in teams. They are capable to use mathematics as a common language. • In doing so, they can communicate new concepts according to the needs of their cooperating partners. Moreover, they can design examples to check and deepen the understanding of their peers.
Autonomy	• Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them. • Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard problems.
Workload in Hours	Independent Study Time 128, Study Time in Lecture 112
Credit points	8
Examination	Written exam
Examination duration and scale	60 min (Analysis I) + 60 min (Linear Algebra I)
Assignment for the Following Curricula	General Engineering Science (German program): Core qualification: Compulsory General Engineering Science (German program, 7 semester): Core qualification: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory Computational Science and Engineering: Core qualification: Compulsory Logistics and Mobility: Core qualification: Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Naval Architecture: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L1010: Analysis I	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	WiSe
Content	Foundations of differential and integrational calculus of one variable • statements, sets and functions • natural and real numbers • convergence of sequences and series • continuous and differentiable functions • mean value theorems • Taylor series • calculus • error analysis • fixpoint iteration
Literature	• http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html

Course L1012: Analysis I	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1013: Analysis I	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0912: Linear Algebra I	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Anusch Taraz, Prof. Marko Lindner
Language	DE
Cycle	WiSe
Content	• vectors: intuition, rules, inner and cross product, lines and planes • general vector spaces: subspaces, Euclidean vector spaces • systems of linear equations: Gauß-elimination, matrix product, inverse matrices, transformations, LR-decomposition, block matrices, determinants
Literature	• T. Arens u.a. : Mathematik, Spektrum Akademischer Verlag, Heidelberg 2009 • W. Mackens, H. Voß: Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994 • W. Mackens, H. Voß: Aufgaben und Lösungen zur Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994

Course L0913: Linear Algebra I	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Anusch Taraz, Prof. Marko Lindner
Language	DE
Cycle	WiSe
Content	• vectors: intuition, rules, inner and cross product, lines and planes • general vector spaces: subspaces, Euclidean vector spaces • systems of linear equations: Gauß-elimination, matrix product, inverse matrices, transformations, LR-decomposition, block matrices, determinants
Literature	• T. Arens u.a. : Mathematik, Spektrum Akademischer Verlag, Heidelberg 2009 • W. Mackens, H. Voß: Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994 • W. Mackens, H. Voß: Aufgaben und Lösungen zur Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994

Course L0914: Linear Algebra I	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Christian Seifert
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0547: Electrical Engineering II: Alternating Current Networks and Basic Devices

Courses

Title	Typ	Hrs/wk	CP
Electrical Engineering II: Alternating Current Networks and Basic Devices (L0178)	Lecture	3	5
Electrical Engineering II: Alternating Current Networks and Basic Devices (L0179)	Recitation Section (small)	2	1

Module Responsible	Prof. Christian Becker
Admission Requirements	None
Recommended Previous Knowledge	Electrical Engineering I Mathematics I Direct current networks, complex numbers
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to reproduce and explain fundamental theories, principles, and methods related to the theory of alternating currents. They can describe networks of linear elements using a complex notation for voltages and currents. They can reproduce an overview of applications for the theory of alternating currents in the area of electrical engineering. Students are capable of explaining the behavior of fundamental passive and active devices as well as their impact on simple circuits.
Skills	Students are capable of calculating parameters within simple electrical networks at alternating currents by means of a complex notation for voltages and currents. They can appraise the fundamental effects that may occur within electrical networks at alternating currents. Students are able to analyze simple circuits such as oscillating circuits, filter, and matching networks quantitatively and dimension elements by means of a design. They can motivate and justify the fundamental elements of an electrical power supply (transformer, transmission line, compensation of reactive power, multiphase system) and are qualified to dimension their main features.
Personal Competence	
Social Competence	Students are able to work together on subject related tasks in small groups. They are able to present their results effectively (e.g. during a week of project work).
Autonomy	Students are capable to gather necessary information from the references provided and relate that information to the context of the lecture. They are able to continually reflect their knowledge by means of activities that accompany the lecture, such as online-tests and exercises that are related to the exam. Based on respective feedback, students are expected to adjust their individual learning process. They are able to draw connections between their knowledge obtained in this lecture and the content of other lectures (e.g. Electrical Engineering I, Linear Algebra, and Analysis).
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Examination	Written exam
Examination duration and scale	90 - 150 minutes
Assignment for the Following Curricula	General Engineering Science (German program): Core qualification: Compulsory General Engineering Science (German program, 7 semester): Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Computational Science and Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory

Course L0178: Electrical Engineering II: Alternating Current Networks and Basic Devices	
Typ	Lecture
Hrs/wk	3
CP	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
Lecturer	Prof. Christian Becker
Language	DE
Cycle	SoSe
Content	- General time-dependency of electrical networks - Representation and properties of harmonic signals - RLC-elements at alternating currents/voltages - Complex notation for the representation of RLC-elements - Power in electrical networks at alternating currents, compensation of reactive power - Frequency response locus (Nyquist plot) and Bode-diagrams - Measurement instrumentation for assessing alternating currents - Oscillating circuits, filters, electrical transmission lines - Transformers, three-phase current, energy converters - Simple non-linear and active electrical devices
Literature	- M. Albach, "Elektrotechnik", Pearson Studium (2011) - T. Harriehausen, D. Schwarzenau, "Moeller Grundlagen der Elektrotechnik", Springer (2013) - R. Kories, H. Schmidt-Walter, "Taschenbuch der Elektrotechnik", Harri Deutsch (2010) - C. Kautz, "Tutorien zur Elektrotechnik", Pearson (2009) - A. Hambley, "Electrical Engineering: Principles and Applications", Pearson (2013) - R. Dorf, "The Electrical Engineering Handbook", CRC (2006)

Course L0179: Electrical Engineering II: Alternating Current Networks and Basic Devices	
Typ	Recitation Section (small)
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Prof. Christian Becker
Language	DE
Cycle	SoSe
Content	- General time-dependency of electrical networks - Representation and properties of harmonic signals - RLC-elements at alternating currents/voltages - Complex notation for the representation of RLC-elements - Power in electrical networks at alternating currents, compensation of reactive power - Frequency response locus (Nyquist plot) and Bode-diagrams - Measurement instrumentation for assessing alternating currents - Oscillating circuits, filters, electrical transmission lines - Transformers, three-phase current, energy converters - Simple non-linear and active electrical devices
Literature	- M. Albach, "Elektrotechnik", Pearson Studium (2011) - T. Harriehausen, D. Schwarzenau, "Moeller Grundlagen der Elektrotechnik", Springer (2013) - R. Kories, H. Schmidt-Walter, "Taschenbuch der Elektrotechnik", Harri Deutsch (2010) - C. Kautz, "Tutorien zur Elektrotechnik", Pearson (2009) - A. Hambley, "Electrical Engineering: Principles and Applications", Pearson (2013) - R. Dorf, "The Electrical Engineering Handbook", CRC (2006)

Module M0553: Objectoriented Programming, Algorithms and Data Structures

Courses			
Title	**Typ**	**Hrs/wk**	**CP**
Objectoriented Programming, Algorithms and Data Structures (L0131)	Lecture	4	4
Objectoriented Programming, Algorithms and Data Structures (L0132)	Recitation Section (small)	1	2

Module Responsible	Prof. Rolf-Rainer Grigat
Admission Requirements	None
Recommended Previous Knowledge	Lecture Prozedurale Programmierung or equivalent proficiency in imperative programming Mandatory prerequisite for this lecture is proficiency in imperative programming (C, Pascal, Fortran or similar). You should be familiar with simple data types (integer, double, char), arrays, if-then-else, for, while, procedure calls or function calls, pointers, and you should have used all those in your own programs and therefore should be proficient with editor, compiler, linker and debugger. In this lecture we will immediately start with the introduction of objects and we will not repeat the basics mentioned above. This remark is especially important for AIW, GES, LUM because those prerequisites are **not** part of the curriculum. They are prerequisites for the start of those curricula in general. The programs ET, CI and IIW include those prerequisites in the first semester in the lecture Prozedurale Programmierung. .
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can explain the essentials of software design and the design of a class architecture with reference to existing class libraries and design patterns. Students can describe fundamental data structures of discrete mathematics and assess the complexity of important algorithms for sorting and searching.
Skills	Students are able to • Design software using given design patterns and applying class hierarchies and polymorphism • Carry out software development and tests using version management systems and Google Test • Sort and search for data efficiently • Assess the complexity of algorithms.
Personal Competence	
Social Competence	Students can work in teams and communicate in forums.
Autonomy	Students are able to solve programming tasks such as LZW data compression using SVN Repository and Google Test independently and over a period of two to three weeks.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Examination	Written exam
Examination duration and scale	60 Minutes, Content of Lecture, exercises and material in StudIP
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory Computer Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory General Engineering Science (English program): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory Computational Science and Engineering: Core qualification: Compulsory Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory Technomathematics: Core qualification: Compulsory

Course L0131: Objectoriented Programming, Algorithms and Data Structures	
Typ	Lecture
Hrs/wk	4
CP	4
Workload in Hours	Independent Study Time 64, Study Time in Lecture 56
Lecturer	Prof. Rolf-Rainer Grigat
Language	DE
Cycle	SoSe
Content	**Object oriented analysis and design:** • Objectoriented programming in C++ and Java • generic programming • UML • design patterns **Data structures and algorithmes:** • complexity of algorithms • searching, sorting, hash tables, • stack, queues, lists, • trees (AVL, heap, 2-3-4, Trie, Huffman, Patricia, B), • sets, priority queues, • directed and undirected graphs (spanning trees, shortest and longest path)
Literature	Skriptum

Course L0132: Objectoriented Programming, Algorithms and Data Structures	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Rolf-Rainer Grigat
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0624: Automata Theory and Formal Languages

Courses			
Title	**Typ**	**Hrs/wk**	**CP**
Automata Theory and Formal Languages (L0332)	Lecture	2	4
Automata Theory and Formal Languages (L0507)	Recitation Section (small)	2	2

Module Responsible	Prof. Tobias Knopp
Admission Requirements	None
Recommended Previous Knowledge	Participating students should be able to - specify algorithms for simple data structures (such as, e.g., arrays) to solve computational problems - apply propositional logic and predicate logic for specifying and understanding mathematical proofs - apply the knowledge and skills taught in the module Discrete Algebraic Structures
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can explain syntax, semantics, and decision problems of propositional logic, and they are able to give algorithms for solving decision problems. Students can show correspondences to Boolean algebra. Students can describe which application problems are hard to represent with propositional logic, and therefore, the students can motivate predicate logic, and define syntax, semantics, and decision problems for this representation formalism. Students can explain unification and resolution for solving the predicate logic SAT decision problem. Students can also describe syntax, semantics, and decision problems for various kinds of temporal logic, and identify their application areas. The participants of the course can define various kinds of finite automata and can identify relationships to logic and formal grammars. The spectrum that students can explain ranges from deterministic and nondeterministic finite automata and pushdown automata to Turing machines. Students can name those formalism for which nondeterminism is more expressive than determinism. They are also able to demonstrate which decision problems require which expressivity, and, in addition, students can transform decision problems w.r.t. one formalism into decision problems w.r.t. other formalisms. They understand that some formalisms easily induce algorithms whereas others are best suited for specifying systems and their properties. Students can describe the relationships between formalisms such as logic, automata, or grammars.
Skills	Students can apply propositional logic as well as predicate logic resolution to a given set of formulas. Students analyze application problems in order to derive propositional logic, predicate logic, or temporal logic formulas to represent them. They can evaluate which formalism is best suited for a particular application problem, and they can demonstrate the application of algorithms for decision problems to specific formulas. Students can also transform nondeterministic automata into deterministic ones, or derive grammars from automata and vice versa. They can show how parsers work, and they can apply algorithms for the language emptiness problem in case of infinite words.
Personal Competence	
Social Competence	
Autonomy	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Computer Science: Elective Compulsory Computer Science: Core qualification: Compulsory General Engineering Science (English program): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Elective Compulsory Computational Science and Engineering: Core qualification: Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L0332: Automata Theory and Formal Languages	
Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Tobias Knopp
Language	EN
Cycle	SoSe
Content	1. Propositional logic, Boolean algebra, propositional resolution, SAT-2KNF 2. Predicate logic, unification, predicate logic resolution 3. Temporal Logics (LTL, CTL) 4. Deterministic finite automata, definition and construction 5. Regular languages, closure properties, word problem, string matching 6. Nondeterministic automata: Rabin-Scott transformation of nondeterministic into deterministic automata 7. Epsilon automata, minimization of automata, elimination of e-edges, uniqueness of the minimal automaton (modulo renaming of states) 8. Myhill-Nerode Theorem: Correctness of the minimization procedure, equivalence classes of strings induced by automata 9. Pumping Lemma for regular languages: provision of a tool which, in some cases, can be used to show that a finite automaton principally cannot be expressive enough to solve a word problem for some given language 10. Regular expressions vs. finite automata: Equivalence of formalisms, systematic transformation of representations, reductions 11. Pushdown automata and context-free grammars: Definition of pushdown automata, definition of context-free grammars, derivations, parse trees, ambiguities, pumping lemma for context-free grammars, transformation of formalisms (from pushdown automata to context-free grammars and back) 12. Chomsky normal form 13. CYK algorithm for deciding the word problem for context-free grammrs 14. Deterministic pushdown automata 15. Deterministic vs. nondeterministic pushdown automata: Application for parsing, LL(k) or LR(k) grammars and parsers vs. deterministic pushdown automata, compiler compiler 16. Regular grammars 17. Outlook: Turing machines and linear bounded automata vs general and context-sensitive grammars 18. Chomsky hierarchy 19. Mealy- and Moore automata: Automata with output (w/o accepting states), infinite state sequences, automata networks 20. Omega automata: Automata for infinite input words, Büchi automata, representation of state transition systems, verification w.r.t. temporal logic specifications (in particular LTL) 21. LTL safety conditions and model checking with Büchi automata, relationships between automata and logic 22. Fixed points, propositional mu-calculus 23. Characterization of regular languages by monadic second-order logic (MSO)
Literature	1. Logik für Informatiker Uwe Schöning, Spektrum, 5. Aufl. 2. Logik für Informatiker Martin Kreuzer, Stefan Kühling, Pearson Studium, 2006 3. Grundkurs Theoretische Informatik, Gottfried Vossen, Kurt-Ulrich Witt, Vieweg-Verlag, 2010. 4. Principles of Model Checking, Christel Baier, Joost-Pieter Katoen, The MIT Press, 2007

Course L0507: Automata Theory and Formal Languages	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Tobias Knopp
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0829: Foundations of Management

Courses			
Title	**Typ**	**Hrs/wk**	**CP**
Introduction to Management (L0880)	Lecture	3	3
Project Entrepreneurship (L0882)	Problem-based Learning	2	3

Module Responsible	Prof. Christoph Ihl
Admission Requirements	None
Recommended Previous Knowledge	Basic Knowledge of Mathematics and Business
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	After taking this module, students know the important basics of many different areas in Business and Management, from Planning and Organisation to Marketing and Innovation, and also to Investment and Controlling. In particular they are able to • explain the differences between Economics and Management and the sub-disciplines in Management and to name important definitions from the field of Management • explain the most important aspects of and goals in Management and name the most important aspects of entreprneurial projects • describe and explain basic business functions as production, procurement and sourcing, supply chain management, organization and human ressource management, information management, innovation management and marketing • explain the relevance of planning and decision making in Business, esp. in situations under multiple objectives and uncertainty, and explain some basic methods from mathematical Finance • state basics from accounting and costing and selected controlling methods.
Skills	Students are able to analyse business units with respect to different criteria (organization, objectives, strategies etc.) and to carry out an Entrepreneurship project in a team. In particular, they are able to • analyse Management goals and structure them appropriately • analyse organisational and staff structures of companies • apply methods for decision making under multiple objectives, under uncertainty and under risk • analyse production and procurement systems and Business information systems • analyse and apply basic methods of marketing • select and apply basic methods from mathematical finance to predefined problems • apply basic methods from accounting, costing and controlling to predefined problems
Personal Competence	
Social Competence	Students are able to • work successfully in a team of students • to apply their knowledge from the lecture to an entrepreneurship project and write a coherent report on the project • to communicate appropriately and • to cooperate respectfully with their fellow students.
Autonomy	Students are able to • work in a team and to organize the team themselves • to write a report on their project.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Examination	Written exam
Examination duration and scale	90 minutes
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program): Specialisation Computer Science: Compulsory General Engineering Science (German program): Specialisation Process Engineering: Compulsory General Engineering Science (German program): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (German program): Specialisation Civil- and Enviromental Engeneering: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program): Specialisation Naval Architecture: Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering:

	Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program): Specialisation Civil- and Enviromental Engeneering: Compulsory General Engineering Science (English program): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (English program): Specialisation Computer Science: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering: Compulsory General Engineering Science (English program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program): Specialisation Naval Architecture: Compulsory General Engineering Science (English program): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory Computational Science and Engineering: Core qualification: Compulsory Logistics and Mobility: Core qualification: Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Naval Architecture: Core qualification: Compulsory Technomathematics: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

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

Course L0882: Project Entrepreneurship	
Typ	Problem-based Learning
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Christoph Ihl, Ann-Isabell Hnida, Hamed Farhadian, Katharina Roedelius, Oliver Welling, Maximilian Muelke
Language	DE
Cycle	WiSe/SoSe
Content	In this project module, students work on an Entrepreneurship project. They are required to go through all relevant steps, from the first idea to the concept, using their knowledge from the corresponding lecture. Project work is carried out in teams with the support of a mentor.
Literature	Relevante Literatur aus der korrespondierenden Vorlesung.

Module M0851: Mathematics II

Courses

Title	Typ	Hrs/wk	CP
Analysis II (L1025)	Lecture	2	2
Analysis II (L1026)	Recitation Section (large)	1	1
Analysis II (L1027)	Recitation Section (small)	1	1
Linear Algebra II (L0915)	Lecture	2	2
Linear Algebra II (L0916)	Recitation Section (small)	1	1
Linear Algebra II (L0917)	Recitation Section (large)	1	1

Module Responsible	Prof. Anusch Taraz
Admission Requirements	none
Recommended Previous Knowledge	Mathematics I
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students can name further concepts in analysis and linear algebra. They are able to explain them using appropriate examples. • Students can discuss logical connections between these concepts. They are capable of illustrating these connections with the help of examples. • They know proof strategies and can reproduce them.
Skills	• Students can model problems in analysis and linear algebra with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods. • Students are able to discover and verify further logical connections between the concepts studied in the course. • For a given problem, the students can develop and execute a suitable approach, and are able to critically evaluate the results.
Personal Competence	
Social Competence	• Students are able to work together in teams. They are capable to use mathematics as a common language. • In doing so, they can communicate new concepts according to the needs of their cooperating partners. Moreover, they can design examples to check and deepen the understanding of their peers.
Autonomy	• Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them. • Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard problems.
Workload in Hours	Independent Study Time 128, Study Time in Lecture 112
Credit points	8
Examination	Written exam
Examination duration and scale	60 min (Analysis II) + 60 min (Linear Algebra II)
Assignment for the Following Curricula	General Engineering Science (German program): Core qualification: Compulsory General Engineering Science (German program, 7 semester): Core qualification: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory Computational Science and Engineering: Core qualification: Compulsory Logistics and Mobility: Core qualification: Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Naval Architecture: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L1025: Analysis II	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	• power series and elementary functions • interpolation • integration (proper integrals, fundamental theorem, integration rules, improper integrals, parameter dependent integrals • applications of integration (volume and surface of bodies of revolution, lines and arc length, line integrals • numerical quadrature • periodic functions
Literature	• http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html

Course L1026: Analysis II	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1027: Analysis II	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0915: Linear Algebra II	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Anusch Taraz, Prof. Marko Lindner
Language	DE
Cycle	SoSe
Content	• linear mappings: basis transformation, orthogonal projection, orthogonal matrices, householder matrices • linear regression: QR-decomposition, normal equations, linear discrete approximation • eigenvalues: diagonalising matrices, normal matrices, symmetric and Hermite matrices, Jordan normal form, singular value decomposition • system of linear differential equations
Literature	• W. Mackens, H. Voß: Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994 • W. Mackens, H. Voß: Aufgaben und Lösungen zur Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994

Course L0916: Linear Algebra II	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Anusch Taraz, Prof. Marko Lindner
Language	DE
Cycle	SoSe
Content	• linear mappings: basis transformation, orthogonal projection, orthogonal matrices, householder matrices • linear regression: QR-decomposition, normal equations, linear discrete approximation • eigenvalues: diagonalising matrices, normal matrices, symmetric and Hermite matrices, Jordan normal form, singular value decomposition • system of linear differential equations
Literature	• W. Mackens, H. Voß: Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994 • W. Mackens, H. Voß: Aufgaben und Lösungen zur Mathematik I für Studierende der Ingenieurwissenschaften, HECO-Verlag, Alsdorf 1994

Course L0917: Linear Algebra II	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Anusch Taraz, Prof. Marko Lindner, Dr. Christian Seifert
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0569: Engineering Mechanics I

Courses			
Title	**Typ**	**Hrs/wk**	**CP**
Engineering Mechanics I (L0187)	Lecture	3	3
Engineering Mechanics I (L0190)	Recitation Section (small)	2	3

Module Responsible	Prof. Uwe Weltin
Admission Requirements	none
Recommended Previous Knowledge	Elementary knowledge in mathematics and physics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to describe fundamental connections, theories and methods to calculate forces in statically determined mounted systems of rigid bodies and fundamentals in elastostatics.
Skills	Students are able to apply theories and methods to calculate forces in statically determined mounted systems of rigid bodies and fundamentals of elastostatics.
Personal Competence	
Social Competence	Students are able to work goal-oriented in small mixed groups, learning and broadening teamwork abilities.
Autonomy	Students are able to solve individually exercises related to this lecture.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Examination	Written exam
Examination duration and scale	90 min.
Assignment for the Following Curricula	Bioprocess Engineering: Core qualification: Compulsory Electrical Engineering: Core qualification: Elective Compulsory Energy and Environmental Engineering: Core qualification: Compulsory Computational Science and Engineering: Core qualification: Compulsory Logistics and Mobility: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L0187: Engineering Mechanics I

Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Uwe Weltin
Language	DE
Cycle	WiSe
Content	Methods to calculate forces in statically determined systems of rigid bodies • Newton-Euler-Method • Energy-Methods Fundamentals of elasticity • Forces and deformations in elastic systems
Literature	• Gross, D.; Hauger, W.; Schröder, J.; Wall, W.A.: Technische Mechanik 1: Statik, Springer Vieweg, 2013 • Gross, D.; Hauger, W.; Schröder, J.; Wall, W.A.: Technische Mechanik 2: Elastostatik, Springer Verlag, 2011 • Gross, D; Ehlers, W.; Wriggers, P.; Schröder, J.; Müller, R.: Formeln und Aufgaben zur Technischen Mechanik 1: Statik, Springer Vieweg, 2013 • Gross, D; Ehlers, W.; Wriggers, P.; Schröder, J.; Müller, R.: Formeln und Aufgaben zur Technischen Mechanik 2: Elastostatik, Springer Verlag, 2011 • Hibbeler, Russel C.: Technische Mechanik 1 Statik, Pearson Studium, 2012 • Hibbeler, Russel C.: Technische Mechanik 2 Festigkeitslehre, Pearson Studium, 2013 • Hauger, W.; Mannl, V.; Wall, W.A.; Werner, E.: Aufgaben zu Technische Mechanik 1-3: Statik, Elastostatik, Kinetik, Springer Verlag, 2011

Course L0190: Engineering Mechanics I

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

Module M0662: Numerical Mathematics I

Courses

Title	Typ	Hrs/wk	CP
Numerical Mathematics I (L0417)	Lecture	2	3
Numerical Mathematics I (L0418)	Recitation Section (small)	2	3

Module Responsible	Prof. Sabine Le Borne
Admission Requirements	None
Recommended Previous Knowledge	• Mathematik I + II for Engineering Students (german or english) **or** Analysis & Linear Algebra I + II for Technomathematicians • basic MATLAB knowledge
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to • name numerical methods for interpolation, integration, least squares problems, eigenvalue problems, nonlinear root finding problems and to explain their core ideas, • repeat convergence statements for the numerical methods, • explain aspects for the practical execution of numerical methods with respect to computational and storage complexitx.
Skills	Students are able to • implement, apply and compare numerical methods using MATLAB, • justify the convergence behaviour of numerical methods with respect to the problem and solution algorithm, • select and execute a suitable solution approach for a given problem.
Personal Competence	
Social Competence	Students are able to • work together in heterogeneously composed teams (i.e., teams from different study programs and background knowledge), explain theoretical foundations and support each other with practical aspects regarding the implementation of algorithms.
Autonomy	Students are capable • to assess whether the supporting theoretical and practical excercises are better solved individually or in a team, • to assess their individual progess and, if necessary, to ask questions and seek help.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Written exam
Examination duration and scale	90 minutes
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Computer Science: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory Bioprocess Engineering: Specialisation A - General Bioprocess Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Electrical Engineering: Core qualification: Elective Compulsory General Engineering Science (English program): Specialisation Computer Science: Compulsory General Engineering Science (English program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory Computational Science and Engineering: Core qualification: Compulsory Process Engineering: Specialisation Process Engineering: Elective Compulsory

Course L0417: Numerical Mathematics I	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Sabine Le Borne, Dr. Patricio Farrell
Language	DE/EN
Cycle	WiSe
Content	1. Error analysis: Number representation, error types, conditioning and stability 2. Interpolation: polynomial and spline interpolation 3. Numerical integration and differentiation: order, Newton-Cotes formula, error estimates, Gaussian quadrature, adaptive quadrature, difference formulas 4. Linear systems: LU and Cholesky factorization, matrix norms, conditioning 5. Linear least squares problems: normal equations, Gram.Schmidt and Householder orthogonalization, singular value decomposition, regularization 6. Eigenvalue problems: power iteration, inverse iteration, QR algorithm 7. Nonlinear systems of equations: Fixed point iteration, root-finding algorithms for real-valued functions, Newton and Quasi-Newton methods for systems
Literature	• Stoer/Bulirsch: Numerische Mathematik 1, Springer • Dahmen, Reusken: Numerik für Ingenieure und Naturwissenschaftler, Springer

Course L0418: Numerical Mathematics I	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Sabine Le Borne, Dr. Patricio Farrell
Language	DE/EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0834: Computernetworks and Internet Security

Courses

Title	Typ	Hrs/wk	CP
Computer Networks and Internet Security (L1098)	Lecture	3	5
Computer Networks and Internet Security (L1099)	Recitation Section (small)	1	1

Module Responsible	Prof. Andreas Timm-Giel
Admission Requirements	None
Recommended Previous Knowledge	Basics of Computer Science
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to explain important and common Internet protocols in detail and classify them, in order to be able to analyse and develop networked systems in further studies and job.
Skills	Students are able to analyse common Internet protocols and evaluate the use of them in different domains.
Personal Competence	
Social Competence	
Autonomy	Students can select relevant parts out of high amount of professional knowledge and can independently learn and understand it.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Computer Science: Elective Compulsory Computer Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Elective Compulsory General Engineering Science (English program): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Elective Compulsory Computational Science and Engineering: Core qualification: Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L1098: Computer Networks and Internet Security

Typ	Lecture
Hrs/wk	3
CP	5
Workload in Hours	Independent Study Time 108, Study Time in Lecture 42
Lecturer	Prof. Andreas Timm-Giel, Prof. Dieter Gollmann
Language	EN
Cycle	WiSe
Content	In this class an introduction to computer networks with focus on the Internet and its security is given. Basic functionality of complex protocols are introduced. Students learn to understand these and identify common principles. In the exercises these basic principles and an introduction to performance modelling are addressed using computing tasks and (virtual) labs. In the second part of the lecture an introduction to Internet security is given. This class comprises: • Application layer protocols (HTTP, FTP, DNS) • Transport layer protocols (TCP, UDP) • Network Layer (Internet Protocol, routing in the Internet) • Data link layer with media access at the example of Ethernet • Multimedia applications in the Internet • Network management • Internet security: IPSec • Internet security: Firewalls
Literature	• Kurose, Ross, Computer Networking - A Top-Down Approach, 6th Edition, Addison-Wesley • Kurose, Ross, Computernetzwerke - Der Top-Down-Ansatz, Pearson Studium; Auflage: 6. Auflage • W. Stallings: Cryptography and Network Security: Principles and Practice, 6th edition Further literature is announced at the beginning of the lecture.

Course L1099: Computer Networks and Internet Security	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Andreas Timm-Giel, Prof. Dieter Gollmann
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0730: Computer Engineering

Courses

Title	Typ	Hrs/wk	CP
Computer Engineering (L0321)	Lecture	3	4
Computer Engineering (L0324)	Recitation Section (small)	1	2

Module Responsible	Prof. Heiko Falk
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge in electrical engineering The successful completion of the labs will be honored during the evaluation of the module's examination according to the following rules: 1. Upon a passed module examination, the student is granted a bonus on the examination's marks due to the successful labs, such that the examination's marks are lifted by 0,3 or 0,4, respectively, up to the next-better grade. 2. The improvement of the grade 5,0 up to 4,3 and of 4,3 up to 4,0 is not possible.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	This module deals with the foundations of the functionality of computing systems. It covers the layers from the assembly-level programming down to gates. The module includes the following topics: • Introduction • Combinational logic: Gates, Boolean algebra, Boolean functions, hardware synthesis, combinational networks • Sequential logic: Flip-flops, automata, systematic hardware design • Technological foundations • Computer arithmetic: Integer addition, subtraction, multiplication and division • Basics of computer architecture: Programming models, MIPS single-cycle architecture, pipelining • Memories: Memory hierarchies, SRAM, DRAM, caches • Input/output: I/O from the perspective of the CPU, principles of passing data, point-to-point connections, busses
Skills	The students perceive computer systems from the architect's perspective, i.e., they identify the internal structure and the physical composition of computer systems. The students can analyze, how highly specific and individual computers can be built based on a collection of few and simple components. They are able to distinguish between and to explain the different abstraction layers of today's computing systems - from gates and circuits up to complete processors. After successful completion of the module, the students are able to judge the interdependencies between a physical computer system and the software executed on it. In particular, they shall understand the consequences that the execution of software has on the hardware-centric abstraction layers from the assembly language down to gates. This way, they will be enabled to evaluate the impact that these low abstraction levels have on an entire system's performance and to propose feasible options.
Personal Competence	
Social Competence	Students are able to solve similar problems alone or in a group and to present the results accordingly.
Autonomy	Students are able to acquire new knowledge from specific literature and to associate this knowledge with other classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Written exam
Examination duration and scale	90 minutes, contents of course and labs
Assignment for the Following Curricula	General Engineering Science (German program): Core qualification: Compulsory General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory Computer Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory General Engineering Science (English program): Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory

	General Engineering Science (English program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory Computational Science and Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L0321: Computer Engineering	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Heiko Falk
Language	DE
Cycle	WiSe
Content	• Introduction • Combinational Logic • Sequential Logic • Technological Foundations • Representations of Numbers, Computer Arithmetics • Foundations of Computer Architecture • Memories • Input/Output
Literature	• A. Clements. The Principles of Computer Hardware. 3. Auflage, Oxford University Press, 2000. • A. Tanenbaum, J. Goodman. Computerarchitektur. Pearson, 2001. • D. Patterson, J. Hennessy. Rechnerorganisation und -entwurf. Elsevier, 2005.

Course L0324: Computer Engineering	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Heiko Falk
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0853: Mathematics III

Courses

Title	Typ	Hrs/wk	CP
Analysis III (L1028)	Lecture	2	2
Analysis III (L1029)	Recitation Section (small)	1	1
Analysis III (L1030)	Recitation Section (large)	1	1
Differential Equations 1 (Ordinary Differential Equations) (L1031)	Lecture	2	2
Differential Equations 1 (Ordinary Differential Equations) (L1032)	Recitation Section (small)	1	1
Differential Equations 1 (Ordinary Differential Equations) (L1033)	Recitation Section (large)	1	1

Module Responsible	Prof. Anusch Taraz
Admission Requirements	none
Recommended Previous Knowledge	Mathematics I + II
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students can name the basic concepts in the area of analysis and differential equations. They are able to explain them using appropriate examples. • Students can discuss logical connections between these concepts. They are capable of illustrating these connections with the help of examples. • They know proof strategies and can reproduce them.
Skills	• Students can model problems in the area of analysis and differential equations with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods. • Students are able to discover and verify further logical connections between the concepts studied in the course. • For a given problem, the students can develop and execute a suitable approach, and are able to critically evaluate the results.
Personal Competence	
Social Competence	• Students are able to work together in teams. They are capable to use mathematics as a common language. • In doing so, they can communicate new concepts according to the needs of their cooperating partners. Moreover, they can design examples to check and deepen the understanding of their peers.
Autonomy	• Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them. • Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard problems.
Workload in Hours	Independent Study Time 128, Study Time in Lecture 112
Credit points	8
Examination	Written exam
Examination duration and scale	60 min (Analysis III) + 60 min (Differential Equations 1)
Assignment for the Following Curricula	General Engineering Science (German program): Core qualification: Compulsory General Engineering Science (German program, 7 semester): Core qualification: Compulsory Civil- and Environmental Engineering: Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program): Core qualification: Compulsory General Engineering Science (English program, 7 semester): Core qualification: Compulsory Computational Science and Engineering: Core qualification: Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Naval Architecture: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L1028: Analysis III	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	WiSe
Content	Main features of differential and integrational calculus of several variables • Differential calculus for several variables • Mean value theorems and Taylor's theorem • Maximum and minimum values • Implicit functions • Minimization under equality constraints • Newton's method for multiple variables • Double integrals over general regions • Line and surface integrals • Theorems of Gauß and Stokes
Literature	• http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html

Course L1029: Analysis III	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1030: Analysis III	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1031: Differential Equations 1 (Ordinary Differential Equations)	
Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	WiSe
Content	Main features of the theory and numerical treatment of ordinary differential equations • Introduction and elementary methods • Exsitence and uniqueness of initial value problems • Linear differential equations • Stability and qualitative behaviour of the solution • Boundary value problems and basic concepts of calculus of variations • Eigenvalue problems • Numerical methods for the integration of initial and boundary value problems • Classification of partial differential equations
Literature	• http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html

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

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

Module M0570: Engineering Mechanics II

Courses			
Title	**Typ**	**Hrs/wk**	**CP**
Engineering Mechanics II (L0191)	Lecture	3	3
Engineering Mechanics II (L0192)	Recitation Section (small)	2	3

Module Responsible	Prof. Uwe Weltin
Admission Requirements	none
Recommended Previous Knowledge	Technical Mechnics I
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to describe connections, theories and methods to calculate forces and motions of rigid bodies in 3D.
Skills	Students are able to apply theories and method to calculate forces and motions of rigid bodies in 3D.
Personal Competence	
Social Competence	Students are able to work goal-oriented in small mixed groups, learning and broadening teamwork abilities.
Autonomy	Students are able to solve individually exercises related to this lecture with instructional direction.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Examination	Written exam
Examination duration and scale	90 min.
Assignment for the Following Curricula	Bioprocess Engineering: Core qualification: Compulsory Electrical Engineering: Core qualification: Elective Compulsory Energy and Environmental Engineering: Core qualification: Compulsory Computational Science and Engineering: Core qualification: Compulsory Logistics and Mobility: Core qualification: Compulsory Process Engineering: Core qualification: Compulsory

Course L0191: Engineering Mechanics II

Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Uwe Weltin
Language	DE
Cycle	SoSe
Content	Method for calculation of forces and motion of rigid bodies in 3D • Newton-Euler-Method • Energy methods
Literature	• Gross, D.; Hauger, W.; Schröder, J.; Wall, W.A.: Technische Mechanik 2: Elastostatik, Springer Verlag, 2011 • Gross, D.; Hauger, W.; Schröder, J.; Wall, W.A.: Technische Mechanik 3: Kinetik, Springer Vieweg, 2012 • Gross, D; Ehlers, W.; Wriggers, P.; Schröder, J.; Müller, R.: Formeln und Aufgaben zur Technischen Mechanik 2: Elastostatik, Springer Verlag, 2011 • Gross, D; Ehlers, W.; Wriggers, P.; Schröder, J.; Müller, R.: Formeln und Aufgaben zur Technischen Mechanik 3: Kinetik, Springer Vieweg, 2012 • Hibbeler, Russel C.: Technische Mechanik 2 Festigkeitslehre, Pearson Studium, 2013 • Hibbeler, Russel C.: Technische Mechanik 3 Dynamik, Pearson Studium, 2012 • Hauger, W.; Mannl, V.; Wall, W.A.; Werner, E.: Aufgaben zu Technische Mechanik 1-3: Statik, Elastostatik, Kinetik, Springer Verlag, 2011

Course L0192: Engineering Mechanics II

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

Module M0672: Signals and Systems

Courses			
Title	**Typ**	**Hrs/wk**	**CP**
Signals and Systems (L0432)	Lecture	3	4
Signals and Systems (L0433)	Recitation Section (large)	1	2

Module Responsible	Prof. Gerhard Bauch
Admission Requirements	None
Recommended Previous Knowledge	Mathematics 1-3 The modul is an introduction to the theory of signals and systems. Good knowledge in maths as covered by the moduls Mathematik 1-3 is expected. Further experience with spectral transformations (Fourier series, Fourier transform, Laplace transform) is useful but not required.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are able to classify and describe signals and linear time-invariant (LTI) systems using methods of signal and system theory. They are able to apply the fundamental transformations of continuous-time and discrete-time signals and systems. They can describe and analyse deterministic signals and systems mathematically in both time and image domain. In particular, they understand the effects in time domain and image domain which are caused by the transition of a continuous-time signal to a discrete-time signal.
Skills	The students are able to describe and analyse deterministic signals and linear time-invariant systems using methods of signal and system theory. They can analyse and design basic systems regarding important properties such as magnitude and phase response, stability, linearity etc.. They can assess the impact of LTI systems on the signal properties in time and frequency domain.
Personal Competence	
Social Competence	The students can jointly solve specific problems.
Autonomy	The students are able to acquire relevant information from appropriate literature sources. They can control their level of knowledge during the lecture period by solving tutorial problems, software tools, clicker system.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program): Specialisation Computer Science: Compulsory General Engineering Science (German program): Specialisation Process Engineering: Compulsory General Engineering Science (German program): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program): Specialisation Civil- and Enviromental Engeneering: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory Computer Science: Core qualification: Compulsory Electrical Engineering: Core qualification: Compulsory General Engineering Science (English program): Specialisation Civil- and Enviromental Engeneering: Compulsory General Engineering Science (English program): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program): Specialisation Computer Science: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering: Compulsory General Engineering Science (English program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory Computational Science and Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory

	Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0432: Signals and Systems	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Gerhard Bauch
Language	DE/EN
Cycle	SoSe

Content	• Basic classification and description of continuous-time and discrete-time signals and systems
	• Concvolution
	• Power and energy of signals
	• Correlation functions of deterministic signals
	• Linear time-invariant (LTI) systems
	• Signal transformations:
	  ∘ Fourier-Series
	  ∘ Fourier Transform
	  ∘ Laplace Transform
	  ∘ Discrete-time Fourier Transform
	  ∘ Discrete Fourier Transform (DFT), Fast Fourier Transform (FFT)
	  ∘ Z-Transform
	• Analysis and design of LTI systems in time and frequency domain
	• Basic filter types
	• Sampling, sampling theorem
	• Fundamentals of recursive and non-recursive discrete-time filters

Literature	• T. Frey , M. Bossert , Signal- und Systemtheorie, B.G. Teubner Verlag 2004 • K. Kammeyer, K. Kroschel, Digitale Signalverarbeitung, Teubner Verlag. • B. Girod ,R. Rabensteiner , A. Stenger , Einführung in die Systemtheorie, B.G. Teubner, Stuttgart, 1997 • J.R. Ohm, H.D. Lüke , Signalübertragung, Springer-Verlag 8. Auflage, 2002 • S. Haykin, B. van Veen: Signals and systems. Wiley. • Oppenheim, A.S. Willsky: Signals and Systems. Pearson. • Oppenheim, R. W. Schafer: Discrete-time signal processing. Pearson.

Course L0433: Signals and Systems	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Gerhard Bauch
Language	DE/EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0803: Embedded Systems

Courses			
Title	**Typ**	**Hrs/wk**	**CP**
Embedded Systems (L0805)	Lecture	3	4
Embedded Systems (L0806)	Recitation Section (small)	1	2

Module Responsible	Prof. Heiko Falk
Admission Requirements	None
Recommended Previous Knowledge	Computer Engineering
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Embedded systems can be defined as information processing systems embedded into enclosing products. This course teaches the foundations of such systems. In particular, it deals with an introduction into these systems (notions, common characteristics) and their specification languages (models of computation, hierarchical automata, specification of distributed systems, task graphs, specification of real-time applications, translations between different models). Another part covers the hardware of embedded systems: Sonsors, A/D and D/A converters, real-time capable communication hardware, embedded processors, memories, energy dissipation, reconfigurable logic and actuators. The course also features an introduction into real-time operating systems, middleware and real-time scheduling. Finally, the implementation of embedded systems using hardware/software co-design (hardware/software partitioning, high-level transformations of specifications, energy-efficient realizations, compilers for embedded processors) is covered.
Skills	After having attended the course, students shall be able to realize simple embedded systems. The students shall realize which relevant parts of technological competences to use in order to obtain a functional embedded systems. In particular, they shall be able to compare different models of computations and feasible techniques for system-level design. They shall be able to judge in which areas of embedded system design specific risks exist.
Personal Competence	
Social Competence	Students are able to solve similar problems alone or in a group and to present the results accordingly.
Autonomy	Students are able to acquire new knowledge from specific literature and to associate this knowledge with other classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Written exam
Examination duration and scale	90 minutes, contents of course and labs
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Computer Science: Elective Compulsory Computer Science: Specialisation Computer and Software Engineering: Elective Compulsory Electrical Engineering: Core qualification: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Elective Compulsory Computational Science and Engineering: Core qualification: Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory

Course L0805: Embedded Systems

Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Heiko Falk
Language	EN
Cycle	SoSe
Content	• Introduction • Specifications and Modeling • Embedded/Cyber-Physical Systems Hardware • System Software • Evaluation and Validation • Mapping of Applications to Execution Platforms • Optimization
Literature	• Peter Marwedel. Embedded System Design - Embedded Systems Foundations of Cyber-Physical Systems. 2nd Edition, Springer, 2012., Springer, 2012.

Course L0806: Embedded Systems	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Heiko Falk
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0852: Graph Theory and Optimization

Courses

Title	Typ	Hrs/wk	CP
Graph Theory and Optimization (L1046)	Lecture	2	3
Graph Theory and Optimization (L1047)	Recitation Section (small)	2	3

Module Responsible	Prof. Anusch Taraz
Admission Requirements	none
Recommended Previous Knowledge	• Discrete Algebraic Structures • Mathematics I
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students can name the basic concepts in Graph Theory and Optimization. They are able to explain them using appropriate examples. • Students can discuss logical connections between these concepts. They are capable of illustrating these connections with the help of examples. • They know proof strategies and can reproduce them.
Skills	• Students can model problems in Graph Theory and Optimization with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods. • Students are able to discover and verify further logical connections between the concepts studied in the course. • For a given problem, the students can develop and execute a suitable approach, and are able to critically evaluate the results.
Personal Competence	
Social Competence	• Students are able to work together in teams. They are capable to use mathematics as a common language. • In doing so, they can communicate new concepts according to the needs of their cooperating partners. Moreover, they can design examples to check and deepen the understanding of their peers.
Autonomy	• Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them. • Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard problems.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory Computer Science: Core qualification: Compulsory General Engineering Science (English program): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory Computational Science and Engineering: Core qualification: Compulsory Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory Technomathematics: Specialisation I. Mathematics: Elective Compulsory

Course L1046: Graph Theory and Optimization	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Anusch Taraz
Language	DE
Cycle	SoSe
Content	• Graphs, search algorithms for graphs, trees • planar graphs • shortest paths • minimum spanning trees • maximum flow and minimum cut • theorems of Menger, König-Egervary, Hall • NP-complete problems • backtracking and heuristics • linear programming • duality • integer linear programming
Literature	• M. Aigner: Diskrete Mathematik, Vieweg, 2004 • J. Matousek und J. Nesetril: Diskrete Mathematik, Springer, 2007 • A. Steger: Diskrete Strukturen (Band 1), Springer, 2001 • A. Taraz: Diskrete Mathematik, Birkhäuser, 2012 • V. Turau: Algorithmische Graphentheorie, Oldenbourg, 2009 • K.-H. Zimmermann: Diskrete Mathematik, BoD, 2006

Course L1047: Graph Theory and Optimization	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Anusch Taraz
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0793: Seminars Computer Science and Mathematics

Courses			
Title	**Typ**	**Hrs/wk**	**CP**
Seminar Computational Mathematics/Computer Science (L0797)	Seminar	2	2
Seminar Computational Engineering Science (L0796)	Seminar	2	2
Seminar Engineering Mathematics/Computer Science (L1781)	Seminar	2	2

Module Responsible	Prof. Karl-Heinz Zimmermann
Admission Requirements	None
Recommended Previous Knowledge	Basic knowledge in Computer Science, Mathematics, and eventually Engineering Science.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students know who to acquire basic knowledge in a rudimentary field of Computer Science, Mathematics, or Engineering Science.
Skills	The students are able to elaborate self-reliantly a rudimentary subfield of Computer Science, Mathematics, or Engineering Science.
Personal Competence	
Social Competence	
Autonomy	
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Examination	Presentation
Examination duration and scale	Pro Seminar erfolgt der Scheinerwerb durch Präsentation (Seminarvortrag 25 min und Diskussion 5 min)
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory Computer Science: Core qualification: Compulsory General Engineering Science (English program): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory Computational Science and Engineering: Core qualification: Compulsory

Course L0797: Seminar Computational Mathematics/Computer Science

Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Karl-Heinz Zimmermann, Dr. Jens-Peter Zemke
Language	DE/EN
Cycle	WiSe/SoSe
Content	• Seminar presentations by enrolled students. Seminar topics from the field of computer-oriented mathematics or computer science are proposed by the organizer • Active participation in discussions.
Literature	Wird vom Seminarveranstalter bekanntgegeben.

Course L0796: Seminar Computational Engineering Science

Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Karl-Heinz Zimmermann
Language	DE/EN
Cycle	WiSe/SoSe
Content	• Seminar presentations by enrolled students. Seminar topics from the field of computer science or engineering science are proposed by the organizer • Active participation in discussions.
Literature	Wird vom Seminarveranstalter bekanntgegeben.

Course L1781: Seminar Engineering Mathematics/Computer Science	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Karl-Heinz Zimmermann, Dr. Jens-Peter Zemke
Language	DE/EN
Cycle	WiSe/SoSe
Content	• Seminar presentations by enrolled students. Seminar topics from the field of computer science or engineering mathematics are proposed by the organizer • Active participation in discussions.
Literature	Wird vom Seminarveranstalter bekanntgegeben.

Module M0833: Introduction to Control Systems

Courses

Title	Typ	Hrs/wk	CP
Introduction to Control Systems (L0654)	Lecture	2	4
Introduction to Control Systems (L0655)	Recitation Section (small)	2	2

Module Responsible	Prof. Herbert Werner
Admission Requirements	none
Recommended Previous Knowledge	Representation of signals and systems in time and frequency domain, Laplace transform
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students can represent dynamic system behavior in time and frequency domain, and can in particular explain properties of first and second order systems • They can explain the dynamics of simple control loops and interpret dynamic properties in terms of frequency response and root locus • They can explain the Nyquist stability criterion and the stability margins derived from it. • They can explain the role of the phase margin in analysis and synthesis of control loops • They can explain the way a PID controller affects a control loop in terms of its frequency response • They can explain issues arising when controllers designed in continuous time domain are implemented digitally
Skills	• Students can transform models of linear dynamic systems from time to frequency domain and vice versa • They can simulate and assess the behavior of systems and control loops • They can design PID controllers with the help of heuristic (Ziegler-Nichols) tuning rules • They can analyze and synthesize simple control loops with the help of root locus and frequency response techniques • They can calculate discrete-time approximations of controllers designed in continuous-time and use it for digital implementation • They can use standard software tools (Matlab Control Toolbox, Simulink) for carrying out these tasks
Personal Competence	
Social Competence	Students can work in small groups to jointly solve technical problems, and experimentally validate their controller designs
Autonomy	Students can obtain information from provided sources (lecture notes, software documentation, experiment guides) and use it when solving given problems. They can assess their knowledge in weekly on-line tests and thereby control their learning progress.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	General Engineering Science (German program): Core qualification: Compulsory General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (German program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory Bioprocess Engineering: Core qualification: Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Electrical Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program): Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Bioprocess Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (English program, 7 semester): Specialisation Civil Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory

	General Engineering Science (English program, 7 semester): Specialisation Process Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Biomechanics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Aircraft Systems Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Materials in Engineering Sciences: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Product Development and Production: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Energy Systems: Compulsory Computational Science and Engineering: Core qualification: Compulsory Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Theoretical Mechanical Engineering: Technical Complementary Course Core Studies: Elective Compulsory Process Engineering: Core qualification: Compulsory

Course L0654: Introduction to Control Systems	
Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	DE
Cycle	WiSe
Content	Signals and systems • Linear systems, differential equations and transfer functions • First and second order systems, poles and zeros, impulse and step response • Stability Feedback systems • Principle of feedback, open-loop versus closed-loop control • Reference tracking and disturbance rejection • Types of feedback, PID control • System type and steady-state error, error constants • Internal model principle Root locus techniques • Root locus plots • Root locus design of PID controllers Frequency response techniques • Bode diagram • Minimum and non-minimum phase systems • Nyquist plot, Nyquist stability criterion, phase and gain margin • Loop shaping, lead lag compensation • Frequency response interpretation of PID control Time delay systems • Root locus and frequency response of time delay systems • Smith predictor Digital control • Sampled-data systems, difference equations • Tustin approximation, digital implementation of PID controllers Software tools • Introduction to Matlab, Simulink, Control toolbox • Computer-based exercises throughout the course
Literature	• Werner, H., Lecture Notes „Introduction to Control Systems“ • G.F. Franklin, J.D. Powell and A. Emami-Naeini "Feedback Control of Dynamic Systems", Addison Wesley, Reading, MA, 2009 • K. Ogata "Modern Control Engineering", Fourth Edition, Prentice Hall, Upper Saddle River, NJ, 2010 • R.C. Dorf and R.H. Bishop, "Modern Control Systems", Addison Wesley, Reading, MA 2010

Course L0655: Introduction to Control Systems	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Herbert Werner
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0727: Stochastics

Courses

Title	Typ	Hrs/wk	CP
Stochastics (L0777)	Lecture	2	4
Stochastics (L0778)	Recitation Section (small)	2	2

Module Responsible	Prof. Marko Lindner
Admission Requirements	none
Recommended Previous Knowledge	• Calculus • Discrete algebraic structures (combinatorics) • Propositional logic
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can explain the main definitions of probability, and they can give basic definitions of modeling elements (random variables, events, dependence, independence assumptions) used in discrete and continuous settings (joint and marginal distributions, density functions). Students can describe characteristic notions such as expected values, variance, standard deviation, and moments. Students can define decision problems and explain algorithms for solving these problems (based on the chain rule or Bayesian networks). Algorithms, or estimators as they are caller, can be analyzed in terms of notions such as bias of an estimator, etc. Student can describe the main ideas of stochastic processes and explain algorithms for solving decision and computation problem for stochastic processes. Students can also explain basic statistical detection and estimation techniques.
Skills	Students can apply algorithms for solving decision problems, and they can justify whether approximation techniques are good enough in various application contexts, i.e., students can derive estimators and judge whether they are applicable or reliable.
Personal Competence	
Social Competence	- Students are able to work together (e.g. on their regular home work) in heterogeneously composed teams (i.e., teams from different study programs and background knowledge) and to present their results appropriately (e.g. during exercise class).
Autonomy	- Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them. - Students can put their knowledge in relation to the contents of other lectures. - Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard problems.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Computer Science: Compulsory Computer Science: Core qualification: Compulsory General Engineering Science (English program): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Compulsory Computational Science and Engineering: Core qualification: Compulsory Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory

Course L0777: Stochastics	
Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Dr. Francisco Javier Hoecker-Escuti
Language	EN
Cycle	SoSe
Content	Foundations of probability theory • Definitions of probability, conditional probability • Random variables, dependencies, independence assumptions, • Marginal and joint probabilities • Distributions and density functions • Characteristics: expected values, variance, standard deviation, moments Practical representations for joint probabilities • Bayessche Netzwerke • Semantik, Entscheidungsprobleme, exakte und approximative Algorithmen Stochastic processes • Stationarity, ergodicity • Correlations • Dynamic Bayesian networks, Hidden Markov networks, Kalman filters, queues Detection & estimation • Detectors • Estimation rules and procedures • Hypothesis and distribution tests • Stochastic regression
Literature	1. Methoden der statistischen Inferenz, Likelihood und Bayes, Held, L., Spektrum 2008 2. Stochastik für Informatiker, Dümbgen, L., Springer 2003 3. Statistik: Der Weg zur Datenanalyse, Fahrmeir, L., Künstler R., Pigeot, I, Tutz, G., Springer 2010 4. Stochastik, Georgii, H.-O., deGruyter, 2009 5. Probability and Random Processes, Grimmett, G., Stirzaker, D., Oxford University Press, 2001 6. Programmieren mit R, Ligges, U., Springer 2008

Course L0778: Stochastics	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Francisco Javier Hoecker-Escuti
Language	EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Specialization Computer Science

Module M0971: Operating Systems

Courses

Title	Typ	Hrs/wk	CP
Operating Systems (L1153)	Lecture	2	3
Operating Systems (L1154)	Recitation Section (small)	2	3

Module Responsible	Prof. Volker Turau
Admission Requirements	None
Recommended Previous Knowledge	• Object-oriented programming, algorithms, and data structures • Procedural programming • Experience in using tools related to operating systems such as editors, linkers, compilers • Experience in using C-libraries
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students explain the main abstractions process, virtual memory, deadlock, lifelock, and file of operations systems, describe the process states and their transitions, and paraphrase the architectural variants of operating systems. They give examples of existing operating systems and explain their architectures. The participants of the course write concurrent programs using threads, conditional variables and semaphores. Students can describe the variants of realizing a file system. Students explain at least three different scheduling algorithms.
Skills	Students are able to use the POSIX libraries for concurrent programming in a correct and efficient way. They are able to judge the efficiency of a scheduling algorithm for a given scheduling task in a given environment.
Personal Competence	
Social Competence	
Autonomy	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Computer Science: Elective Compulsory Computer Science: Core qualification: Compulsory General Engineering Science (English program): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L1153: Operating Systems

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Volker Turau
Language	DE
Cycle	SoSe
Content	• Architectures for Operating Systems • Processes • Concurrency • Deadlocks • Memory organization • Scheduling • File systems
Literature	1. Operating Systems, William Stallings, Pearson International Edition 2. Moderne Betriebssysteme, Andrew Tanenbaum, Pearson Studium

Course L1154: Operating Systems	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Volker Turau
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0732: Software Engineering

Courses			
Title	**Typ**	**Hrs/wk**	**CP**
Software Engineering (L0627)	Lecture	2	3
Software Engineering (L0628)	Recitation Section (small)	2	3

Module Responsible	Prof. Sibylle Schupp
Admission Requirements	None
Recommended Previous Knowledge	• Automata theory and formal languages • Procedural programming or Functional programming • Object-oriented programming, algorithms, and data structures
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students explain the phases of the software life cycle, describe the fundamental terminology and concepts of software engineering, and paraphrase the principles of structured software development. They give examples of software-engineering tasks of existing large-scale systems. They write test cases for different test strategies and devise specifications or models using different notations, and critique both. They explain simple design patterns and the major activities in requirements analysis, maintenance, and project planning.
Skills	For a given task in the software life cycle, students identify the corresponding phase and select an appropriate method. They choose the proper approach for quality assurance. They design tests for realistic systems, assess the quality of the tests, and find errors at different levels. They apply and modify non-executable artifacts. They integrate components based on interface specifications.
Personal Competence	
Social Competence	Students practice peer programming. They explain problems and solutions to their peer. They communicate in English.
Autonomy	Using on-line quizzes and accompanying material for self study, students can assess their level of knowledge continuously and adjust it appropriately. Working on exercise problems, they receive additional feedback.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Computer Science: Elective Compulsory Computer Science: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L0627: Software Engineering

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Sibylle Schupp
Language	EN
Cycle	SoSe
Content	• Software Life Cycle Models (Waterfall, V-Model, Evolutionary Models, IncrementalModels, Iterative Models, Agile Processes) • Requirements (Elicitation Techniques, UML Use Case Diagrams, Functional and Non-Functional Requirements) • Specification (Finite State Machines, Extended FSMs, Petri Nets, Behavioral UML Diagrams, Data Modeling) • Design (Design Concepts, Modules, (Agile) Design Principles) • Object-Oriented Analysis and Design (Object Identification, UML Interaction Diagrams, UML Class Diagrams, Architectural Patterns) • Testing (Blackbox Testing, Whitebox Testing, Control-Flow Testing, Data-Flow Testing, Testing in the Large) • Maintenance and Evolution (Regression Testing, Reverse Engineering, Reengineering) • Project Management (Blackbox Estimation Techniques, Whitebox Estimation Techniques, Project Plans, Gantt Charts, PERT Charts)
Literature	Kassem A. Saleh, Software Engineering, J. Ross Publishing 2009.

Course L0628: Software Engineering

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

Module M0562: Computability and Complexity Theory

Courses			
Title	**Typ**	**Hrs/wk**	**CP**
Computability and Complexity Theory (L0166)	Lecture	2	3
Computability and Complexity Theory (L0167)	Recitation Section (small)	2	3

Module Responsible	Prof. Karl-Heinz Zimmermann
Admission Requirements	None.
Recommended Previous Knowledge	Discrete Algebraic Structures, Automata Theory, Logic, and Formal Language Theory.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students known the important machine models of computability, the class of partial recursive functions, universal computability, Gödel numbering of computations, the theorems of Kleene, Rice, and Rice-Shapiro, the concept of decidable and undecidable sets, the word problems for semi-Thue systems, Thue systems, semi-groups, and Post correspondence systems, Hilbert's 10-th problem, and the basic concepts of complexity theory.
Skills	Students are able to investigate the computability of sets and functions and to analyze the complexity of computable functions.
Personal Competence	
Social Competence	Students are able to solve specific problems alone or in a group and to present the results accordingly.
Autonomy	Students are able to acquire new knowledge from newer literature and to associate the acquired knowledge with other classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Oral exam
Examination duration and scale	20 min
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Computer Science: Elective Compulsory Computer Science: Core qualification: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory Technomathematics: Core qualification: Elective Compulsory

Course L0166: Computability and Complexity Theory

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Karl-Heinz Zimmermann
Language	DE/EN
Cycle	SoSe
Content	
Literature	

Course L0167: Computability and Complexity Theory

Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Karl-Heinz Zimmermann
Language	DE/EN
Cycle	SoSe
Content	
Literature	

Module M0854: Mathematics IV

Courses

Title	Typ	Hrs/wk	CP
Differential Equations 2 (Partial Differential Equations) (L1043)	Lecture	2	1
Differential Equations 2 (Partial Differential Equations) (L1044)	Recitation Section (small)	1	1
Differential Equations 2 (Partial Differential Equations) (L1045)	Recitation Section (large)	1	1
Complex Functions (L1038)	Lecture	2	1
Complex Functions (L1041)	Recitation Section (small)	1	1
Complex Functions (L1042)	Recitation Section (large)	1	1

Module Responsible	Prof. Anusch Taraz
Admission Requirements	none
Recommended Previous Knowledge	Mathematics 1 - III
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students can name the basic concepts in Mathematics IV. They are able to explain them using appropriate examples. • Students can discuss logical connections between these concepts. They are capable of illustrating these connections with the help of examples. • They know proof strategies and can reproduce them.
Skills	• Students can model problems in Mathematics IV with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods. • Students are able to discover and verify further logical connections between the concepts studied in the course. • For a given problem, the students can develop and execute a suitable approach, and are able to critically evaluate the results.
Personal Competence	
Social Competence	• Students are able to work together in teams. They are capable to use mathematics as a common language. • In doing so, they can communicate new concepts according to the needs of their cooperating partners. Moreover, they can design examples to check and deepen the understanding of their peers.
Autonomy	• Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them. • Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard problems.
Workload in Hours	Independent Study Time 68, Study Time in Lecture 112
Credit points	6
Examination	Written exam
Examination duration and scale	60 min (Complex Functions) + 60 min (Differential Equations 2)
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program): Specialisation Naval Architecture: Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Electrical Engineering: Core qualification: Compulsory General Engineering Science (English program): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program): Specialisation Naval Architecture: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory Mechanical Engineering: Specialisation Mechatronics: Compulsory Mechatronics: Core qualification: Compulsory Naval Architecture: Core qualification: Compulsory Theoretical Mechanical Engineering: Technical Complementary Course Core Studies: Elective Compulsory

Course L1043: Differential Equations 2 (Partial Differential Equations)	
Typ	Lecture
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	Main features of the theory and numerical treatment of partial differential equations • Examples of partial differential equations • First order quasilinear differential equations • Normal forms of second order differential equations • Harmonic functions and maximum principle • Maximum principle for the heat equation • Wave equation • Liouville's formula • Special functions • Difference methods • Finite elements
Literature	• http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html

Course L1044: Differential Equations 2 (Partial Differential Equations)	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1045: Differential Equations 2 (Partial Differential Equations)	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1038: Complex Functions	
Typ	Lecture
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	Main features of complex analysis • Functions of one complex variable • Complex differentiation • Conformal mappings • Complex integration • Cauchy's integral theorem • Cauchy's integral formula • Taylor and Laurent series expansion • Singularities and residuals • Integral transformations: Fourier and Laplace transformation
Literature	• http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html

Course L1041: Complex Functions	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1042: Complex Functions	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0791: Computer Architecture

Courses

Title	Typ	Hrs/wk	CP
Computer Architecture (L0793)	Lecture	2	3
Computer Architecture (L0794)	Problem-based Learning	2	2
Computer Architecture (L1864)	Recitation Section (small)	1	1

Module Responsible	Prof. Heiko Falk
Admission Requirements	None
Recommended Previous Knowledge	Module "Computer Engineering"
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	This module presents advanced concepts from the discipline of computer architecture. In the beginning, a broad overview over various programming models is given, both for general-purpose computers and for special-purpose machines (e.g., signal processors). Next, foundational aspects of the micro-architecture of processors are covered. Here, the focus particularly lies on the so-called pipelining and the methods used for the acceleration of instruction execution used in this context. The students get to know concepts for dynamic scheduling, branch prediction, superscalar execution of machine instructions and for memory hierarchies.
Skills	The students are able to describe the organization of processors. They know the different architectural principles and programming models. The students examine various structures of pipelined processor architectures and are able to explain their concepts and to analyze them w.r.t. criteria like, e.g., performance or energy efficiency. They evaluate different structures of memory hierarchies, know parallel computer architectures and are able to distinguish between instruction- and data-level parallelism.
Personal Competence	
Social Competence	Students are able to solve similar problems alone or in a group and to present the results accordingly.
Autonomy	Students are able to acquire new knowledge from specific literature and to associate this knowledge with other classes.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Examination	Written exam
Examination duration and scale	90 minutes, contents of course and 4 attestations from the PBL "Computer architecture"
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Computer Science: Elective Compulsory Computer Science: Specialisation Computer and Software Engineering: Elective Compulsory General Engineering Science (English program): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory

Course L0793: Computer Architecture

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Heiko Falk
Language	DE/EN
Cycle	WiSe
Content	• Introduction • VHDL Basics • Programming Models • Realization of Elementary Data Types • Dynamic Scheduling • Branch Prediction • Superscalar Machines • Memory Hierarchies The theoretical tutorials amplify the lecture's content by solving and discussing exercise sheets and thus serve as exam preparation. Practical aspects of computer architecture are taught in the FPGA-based PBL on computer architecture whose attendance is mandatory.
Literature	• D. Patterson, J. Hennessy. Rechnerorganisation und -entwurf. Elsevier, 2005. • A. Tanenbaum, J. Goodman. Computerarchitektur. Pearson, 2001.

Course L0794: Computer Architecture	
Typ	Problem-based Learning
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Heiko Falk
Language	DE/EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1864: Computer Architecture	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Heiko Falk
Language	DE/EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0972: Distributed Systems

Courses			
Title	**Typ**	**Hrs/wk**	**CP**
Distributed Systems (L1155)	Lecture	2	3
Distributed Systems (L1156)	Recitation Section (small)	2	3

Module Responsible	Prof. Volker Turau
Admission Requirements	None
Recommended Previous Knowledge	• Procedural programming • Object-oriented programming with Java • Networks • Socket programming
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students explain the main abstractions of Distributed Systems (Marshalling, proxy, service, address, Remote procedure call, synchron/asynchron system). They describe the pros and cons of different types of interprocess communication. They give examples of existing middleware solutions. The participants of the course know the main architectural variants of distributed systems, including their pros and cons. Students can describe at least three different synchronization mechanisms.
Skills	Students can realize distributed systems using at least three different techniques: • Proprietary protocol realized with TCP • HTTP as a remote procedure call • RMI as a middleware
Personal Competence	
Social Competence	
Autonomy	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Written exam
Examination duration and scale	120 min
Assignment for the Following Curricula	Computer Science: Specialisation Computer and Software Engineering: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L1155: Distributed Systems

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Volker Turau
Language	DE
Cycle	WiSe
Content	• Architectures for distributed systems • HTTP: Simple remote procedure call • Client-Server Architectures • Remote procedure call • Remote Method Invocation (RMI) • Synchronization • Distributed Caching • Name servers • Distributed File systems
Literature	• Verteilte Systeme – Prinzipien und Paradigmen, Andrew S. Tanenbaum, Maarten van Steen, Pearson Studium • Verteilte Systeme, G. Coulouris, J. Dollimore, T. Kindberg, 2005, Pearson Studium

Course L1156: Distributed Systems

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

Module M0863: Numerics and Computer Algebra

Courses

Title	Typ	Hrs/wk	CP
Numerical Mathematics and Computer Algebra (L0115)	Lecture	2	3
Numerics and Computer Algebra (L1060)	Seminar	2	2
Numerical Mathematics and Computer Algebra (L0117)	Recitation Section (small)	1	1

Module Responsible	Prof. Siegfried Rump
Admission Requirements	none
Recommended Previous Knowledge	Basic knowledge in numerics and discrete mathematics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students know the difference between precision and accuracy. For several basic problems they know how to solve them approximatively and exactly. They can distinguish between efficiently, not efficiently and principally unsolvable problems.
Skills	The students are able to analyze complex problems in mathematics and computer science. In particular they can analyze the sensitivity of the solution. For several problems they can derive best possible algorithms with respect to the accuracy of the computed result.
Personal Competence	
Social Competence	The students have the skills to solve problems together in small groups and to present the achieved results in an appropriate manner.
Autonomy	The students are able to retrieve necessary informations from the given literature and to combine them with the topics of the lecture. Throughout the lecture they can check their abilities and knowledge on the basis of given exercises and test questions providing an aid to optimize their learning process.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Examination	Oral exam
Examination duration and scale	30 min
Assignment for the Following Curricula	Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory Technomathematics: Core qualification: Elective Compulsory

Course L0115: Numerical Mathematics and Computer Algebra

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Siegfried Rump
Language	DE
Cycle	WiSe
Content	• Basic knowledge in numerical algorithms • Algorithms • Floating-point arithmetic, IEEE 754 • Arithmetic by Sunage (Avizienis), Olver, Matula • continued fractions · Basic Linear Algebra Subroutines (BLAS) • Computer Algebra methods • Matlab and operator concept • Turing machines and computability • Church's Axiom • Busy Beaver function • NP classes • Travelling salesman problem
Literature	Higham, N.J.: Accuracy and stability of numerical algorithms, SIAM Publications, Philadelphia, 2nd edition, 2002 Golub, G.H. and Van Loan, Ch.: Matrix Computations, John Hopkins University Press, 3rd edition, 1996 Knuth, D.E.: The Art of Computer Programming: Seminumerical Algorithms, Vol. 2. Addison Wesley, Reading, Massachusetts, 1969

Course L1060: Numerics and Computer Algebra	
Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Siegfried Rump
Language	DE
Cycle	WiSe
Content	Seminar accompanying the lectures (q.v. lecture contents)
Literature	Higham, N.J.: Accuracy and stability of numerical algorithms, SIAM Publications, Philadelphia, 2nd edition, 2002 Golub, G.H. and Van Loan, Ch.: Matrix Computations, John Hopkins University Press, 3rd edition, 1996 Knuth, D.E.: The Art of Computer Programming: Seminumerical Algorithms, Vol. 2. Addison Wesley, Reading, Massachusetts, 1969

Course L0117: Numerical Mathematics and Computer Algebra	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Siegfried Rump
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0941: Combinatorial Structures and Algorithms

Courses

Title	Typ	Hrs/wk	CP
Combinatorial Structures and Algorithms (L1100)	Lecture	3	4
Combinatorial Structures and Algorithms (L1101)	Recitation Section (small)	1	2

Module Responsible	Prof. Anusch Taraz
Admission Requirements	None
Recommended Previous Knowledge	• Mathematics I + II • Discrete Algebraic Structures • Graph Theory and Optimization
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students can name the basic concepts in Combinatorics and Algorithms. They are able to explain them using appropriate examples. • Students can discuss logical connections between these concepts. They are capable of illustrating these connections with the help of examples. • They know proof strategies and can reproduce them.
Skills	• Students can model problems in Combinatorics and Algorithms with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods. • Students are able to discover and verify further logical connections between the concepts studied in the course. • For a given problem, the students can develop and execute a suitable approach, and are able to critically evaluate the results.
Personal Competence	
Social Competence	• Students are able to work together in teams. They are capable to use mathematics as a common language. • In doing so, they can communicate new concepts according to the needs of their cooperating partners. Moreover, they can design examples to check and deepen the understanding of their peers.
Autonomy	• Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them. • Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard problems.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Oral exam
Examination duration and scale	30 min
Assignment for the Following Curricula	Computer Science: Specialisation Computer and Software Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory Technomathematics: Specialisation I. Mathematics: Elective Compulsory

Course L1100: Combinatorial Structures and Algorithms

Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Anusch Taraz
Language	DE/EN
Cycle	WiSe
Content	• Counting • Structural Graph Theory • Analysis of Algorithms • Extremal Combinatorics • Random discrete structures
Literature	• M. Aigner: Diskrete Mathematik, Vieweg, 6. Aufl., 2006 • J. Matoušek & J. Nešetřil: Diskrete Mathematik - Eine Entdeckungsreise, Springer, 2007 • A. Steger: Diskrete Strukturen - Band 1: Kombinatorik, Graphentheorie, Algebra, Springer, 2. Aufl. 2007 • A. Taraz: Diskrete Mathematik, Birkhäuser, 2012.

Course L1101: Combinatorial Structures and Algorithms	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Anusch Taraz
Language	DE/EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0953: Introduction to Information Security

Courses			
Title	**Typ**	**Hrs/wk**	**CP**
Introduction to Information Security (L1114)	Lecture	3	3
Introduction to Information Security (L1115)	Recitation Section (small)	2	3

Module Responsible	Prof. Dieter Gollmann
Admission Requirements	None
Recommended Previous Knowledge	Basics of Computer Science
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can • name the main security risks when using Information and Communication Systems and name the fundamental security mechanisms, • describe commonly used methods for risk and security analysis, • name the fundamental principles of data protection.
Skills	Students can • evaluate the strenghts and weaknesses of the fundamental security mechanisms and of the commonly used methods for risk and security analysis, • apply the fundamental principles of data protection to concrete cases.
Personal Competence	
Social Competence	Students are capable of appreciating the impact of security problems on those affected and of the potential responsibilities for their resolution.
Autonomy	None
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Examination	Written exam
Examination duration and scale	120 minutes
Assignment for the Following Curricula	Computer Science: Core qualification: Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L1114: Introduction to Information Security	
Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Chris Brzuska, Prof. Dieter Gollmann
Language	EN
Cycle	WiSe
Content	• Fundamental concepts • Passwords & biometrics • Introduction to cryptography • Sessions, SSL/TLS • Certificates, electronic signatures • Public key infrastructures • Side-channel analysis • Access control • Privacy • Software security basics • Security management & risk analysis • Security evaluation: Common Criteria
Literature	D. Gollmann: Computer Security, Wiley & Sons, third edition, 2011 Ross Anderson: Security Engineering, Wiley & Sons, second edition, 2008

Course L1115: Introduction to Information Security	
Typ	Recitation Section (small)
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Dieter Gollmann
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0731: Functional Programming

Courses

Title	Typ	Hrs/wk	CP
Functional Programming (L0624)	Lecture	2	2
Functional Programming (L0625)	Recitation Section (large)	2	2
Functional Programming (L0626)	Recitation Section (small)	2	2

Module Responsible	Prof. Sibylle Schupp
Admission Requirements	None
Recommended Previous Knowledge	Discrete mathematics at high-school level
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students apply the principles, constructs, and simple design techniques of functional programming. They demonstrate their ability to read Haskell programs and to explain Haskell syntax as well as Haskell's read-eval-print loop. They interpret warnings and find errors in programs. They apply the fundamental data structures, data types, and type constructors. They employ strategies for unit tests of functions and simple proof techniques for partial and total correctness. They distinguish laziness from other evaluation strategies.
Skills	Students break a natural-language description down in parts amenable to a formal specification and develop a functional program in a structured way. They assess different language constructs, make conscious selections both at specification and implementations level, and justify their choice. They analyze given programs and rewrite them in a controlled way. They design and implement unit tests and can assess the quality of their tests. They argue for the correctness of their program.
Personal Competence	
Social Competence	Students practice peer programming with varying peers. They explain problems and solutions to their peer. They defend their programs orally. They communicate in English.
Autonomy	In programming labs, students learn under supervision (a.k.a. "Betreutes Programmieren") the mechanics of programming. In exercises, they develop solutions individually and independently, and receive feedback.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Computer Science: Compulsory General Engineering Science (German program, 7 semester): Specialisation Computer Science: Elective Compulsory Computer Science: Core qualification: Compulsory General Engineering Science (English program): Specialisation Computer Science: Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L0624: Functional Programming

Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Sibylle Schupp
Language	EN
Cycle	WiSe
Content	• Functions, Currying, Recursive Functions, Polymorphic Functions, Higher-Order Functions • Conditional Expressions, Guarded Expressions, Pattern Matching, Lambda Expressions • Types (simple, composite), Type Classes, Recursive Types, Algebraic Data Type • Type Constructors: Tuples, Lists, Trees, Associative Lists (Dictionaries, Maps) • Modules • Interactive Programming • Lazy Evaluation, Call-by-Value, Strictness • Design Recipes • Testing (axiom-based, invariant-based, against reference implementation) • Reasoning about Programs (equation-based, inductive) • Idioms of Functional Programming • Haskell Syntax and Semantics
Literature	Graham Hutton, Programming in Haskell, Cambridge University Press 2007.

Course L0625: Functional Programming	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Sibylle Schupp
Language	EN
Cycle	WiSe
Content	• Functions, Currying, Recursive Functions, Polymorphic Functions, Higher-Order Functions • Conditional Expressions, Guarded Expressions, Pattern Matching, Lambda Expressions • Types (simple, composite), Type Classes, Recursive Types, Algebraic Data Type • Type Constructors: Tuples, Lists, Trees, Associative Lists (Dictionaries, Maps) • Modules • Interactive Programming • Lazy Evaluation, Call-by-Value, Strictness • Design Recipes • Testing (axiom-based, invariant-based, against reference implementation) • Reasoning about Programs (equation-based, inductive) • Idioms of Functional Programming • Haskell Syntax and Semantics
Literature	Graham Hutton, Programming in Haskell, Cambridge University Press 2007.

Course L0626: Functional Programming	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Sibylle Schupp
Language	EN
Cycle	WiSe
Content	• Functions, Currying, Recursive Functions, Polymorphic Functions, Higher-Order Functions • Conditional Expressions, Guarded Expressions, Pattern Matching, Lambda Expressions • Types (simple, composite), Type Classes, Recursive Types, Algebraic Data Type • Type Constructors: Tuples, Lists, Trees, Associative Lists (Dictionaries, Maps) • Modules • Interactive Programming • Lazy Evaluation, Call-by-Value, Strictness • Design Recipes • Testing (axiom-based, invariant-based, against reference implementation) • Reasoning about Programs (equation-based, inductive) • Idioms of Functional Programming • Haskell Syntax and Semantics
Literature	Graham Hutton, Programming in Haskell, Cambridge University Press 2007.

Module M1242: Quantum Mechanics for Engineers

Courses

Title	Typ	Hrs/wk	CP
Quantum Mechanics for Engineers (L1686)	Lecture	2	3
Quantum Mechanics for Engineers (L1688)	Recitation Section (small)	2	3

Module Responsible	Prof. Wolfgang Hansen
Admission Requirements	None
Recommended Previous Knowledge	• Knowledge in physics, particularly in optics and wave phenomena; • knowledge in mathematics, particularly linear algebra, vector calculus, complex numbers and Fourier expansion
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are able to describe and explain basic terms and principles of quantum mechanics. They can distinguish commons and differences to classical physics and know, in which situations quantum mechanical phenomena may be expected.
Skills	The students get the ability to apply concepts and methods of quantum mechanics to simple problems and systems. Vice versa, they are also able to comprehend requirements and principles of quantum mechanical devices.
Personal Competence	
Social Competence	The students discuss contents of the lectures and present solutions to simple quantum mechanical problems in small groups during the exercises.
Autonomy	The students are able to independently find answers to simple questions on quantum mechanical systems. The students are able to independently comprehend literature to more complex subjects with quantum mechanical background.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Written exam
Examination duration and scale	90 minutes
Assignment for the Following Curricula	Computer Science: Specialisation Computer and Software Engineering: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory Electrical Engineering: Core qualification: Elective Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory

Course L1686: Quantum Mechanics for Engineers

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Wolfgang Hansen
Language	DE
Cycle	WiSe
Content	This lecture introduces into fundamental concepts, methods, and definitions in quantum mechanics, which are needed in modern material and device science. Applications will be discussed using examples in the field of electronic and optical devices. Central topics are: Schrödinger equation, wave function, operators, eigenstates, eigenvalues, quantum wells, harmonic oscillator, tunnel processes, resonant tunnel diode, band structure, density of states, quantum statistics, Zener-diode, stationary perturbation calculation with the quantum-confined Stark effect as an example, Fermi's golden rule and transition matrix elements, heterostructure laser, quantum cascade laser, many-particle physics, molecules and exchange interaction, quantum bits and quantum cryptography.
Literature	• David J. Griffiths: "Quantenmechanik, eine Einführung", Pearson (2012), ISBN 978-3-8632-6514-4. • David K. Ferry: "Quantum Mechanics", IOP Publishing (1995), ISBN 0-7503-0327-1 (hbk) bzw. 0-7503-0328-X (pbk). • M. Jaros: " Physics and Applications of Semiconductor Microstructures ", Clarendon Press (1989), ISBN: 0-19-851994-X bzw. 0-19-853927-4 (Pbk). • Randy Harris, "Moderne Physik Lehr- und Übungsbuch", 2. aktualisierte Auflage, Kapitel 3-10, Pearson (2013), ISBN 978-3-86894-115-9. • Michael A Nielsen and Isaac L. Chuang: "Quantum Computation and Quantum Informatioin", 10. Auflage, Cambridge University Press (2011), ISBN: 1107002176 9781107002173. • Hiroyuki Sagawa and Nobuaki Yoshida: "Fundamentals of Quantum Information", World Scientific Publishing (2010), ISBN-13: 978-9814324236.

Course L1688: Quantum Mechanics for Engineers

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

Module M0783: Measurements: Methods and Data Processing

Courses

Title	Typ	Hrs/wk	CP
EE Experimental Lab (L0781)	Laboratory Course	2	2
Measurements: Methods and Data Processing (L0779)	Lecture	2	3
Measurements: Methods and Data Processing (L0780)	Recitation Section (small)	1	1

Module Responsible	Prof. Alexander Schlaefer
Admission Requirements	none
Recommended Previous Knowledge	principles of mathematics principles of electrical engineering
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are able to explain the purpose of metrology and the acquisition and processing of measurements. They can detail aspects of probability theory and errors, and explain the processing of stochastic signals. Students know methods to digitalize and describe measured signals.
Skills	The students are able to evaluate problems of metrology and to apply methods for describing and processing of measurements.
Personal Competence	
Social Competence	The students solve problems in small groups.
Autonomy	The students can reflect their knowledge and discuss and evaluate their results.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Elective Compulsory Computer Science: Specialisation Computer and Software Engineering: Elective Compulsory Electrical Engineering: Core qualification: Compulsory General Engineering Science (English program): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Elective Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Technomathematics: Core qualification: Elective Compulsory

Course L0781: EE Experimental Lab

Typ	Laboratory Course
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer, Prof. Christian Schuster, Prof. Günter Ackermann, Prof. Rolf-Rainer Grigat, Prof. Arne Jacob, Prof. Herbert Werner, Dozenten des SD E, Prof. Heiko Falk
Language	DE
Cycle	WiSe
Content	lab experiments: digital circuits, semiconductors, micro controllers, analog circuits, AC power, electrical machines
Literature	Wird in der Lehrveranstaltung festgelegt

Course L0779: Measurements: Methods and Data Processing

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	DE
Cycle	WiSe
Content	introduction, systems and errors in metrology, probability theory, measuring stochastic signals, describing measurements, acquisition of analog signals, applied metrology
Literature	Puente León, Kiencke: Messtechnik, Springer 2012 Lerch: Elektrische Messtechnik, Springer 2012 Weitere Literatur wird in der Veranstaltung bekanntgegeben.

Course L0780: Measurements: Methods and Data Processing	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Alexander Schlaefer
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0625: Databases

Courses

Title	Typ	Hrs/wk	CP
Databases (L0337)	Lecture	4	5
Databases (L1150)	Problem-based Learning	1	1

Module Responsible	NN
Admission Requirements	None
Recommended Previous Knowledge	Students should habe basic knowledge in the following areas: • Discrete Algebraic Structures • Procedural Programming • Logic, Automata, and Formal Languages • Object-Oriented Programming, Algorithms and Data Structures
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can explain the general architecture of an application system that is based on a database. They describe the syntax and semantics of the Entity Relationship conceptual modeling languages, and they can enumerate basic decision problems and know which features of a domain model can be captured with ER and which features cannot be represented. Furthermore, students can summarize the features of the relational data model, and can describe how ER models can be systematically transformed into the relational data model. Student are able to discuss dependency theory using the operators of relational algebra, and they know how to use relational algebra as a query language. In addition, they can sketch the main modules of the architecture of a database system from an implementation point of view. Storage and index structures as well as query answering and optimization techniques can be explained. The role of transactions can be described in terms of ACID conditions and common recovery mechanisms can be characterized. The students can recall why recursion is important for query languages and describe how Datalog can be used and implemented.They demonstrate how Datalog can be used for information integration. For solving ER decision problems the students can explain description logics with their syntax and semantics, they describe description logic decision problems and explain how these problems can be mapped onto each other. They can sketch the idea of ontology-based data access and can name the main complexity measure in database theory. Last but not least, the students can describe the main features of XML and can explain XPath and XQuery as query languages.
Skills	Students can apply ER for describing domains for which they receive a textual description, and students can transform relational schemata with a given set of functional dependencies into third normal form or even Boyce-Codd normal form. They can also apply relational algebra, SQL, or Datalog to specify queries. Using specific datasets, they can explain how index structures work (e.g., B-trees) and how index structures change while data is added or deleted. They can rewrite queries for better performance of query evaluation. Students can analyse which query language expressivity is required for which application problem. Description logics can be applied for domain modeling, and students can transform ER diagrams into description logics in order to check for consistency and implicit subsumption relations. They solve data integration problems using Datalog and LAV or GAV rules. Students can apply XPath and Xquery to retrieve certain patterns in XML data.
Personal Competence	
Social Competence	Students develop an understanding of social structures in a company used for developing real-world products. They know the responsibilities of data analysts, programmers, and managers in the overall production process.
Autonomy	
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	Computer Science: Specialisation Computer and Software Engineering: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory Technomathematics: Core qualification: Elective Compulsory

Course L0337: Databases	
Typ	Lecture
Hrs/wk	4
CP	5
Workload in Hours	Independent Study Time 94, Study Time in Lecture 56
Lecturer	NN
Language	EN
Cycle	WiSe
Content	• Architecture of database systems, conceptual data modeling with the Entity Relationship (ER) modeling language • Relational data model, referential integrity, keys, foreign keys, functional dependencies (FDs), canonical mapping of entity types and relationship into the relational data model, anomalies • Relational algebra as a simple query language • Dependency theory, FD closure, canonical cover of FD set, decomposition of relational schemata, multivalued dependencies, normalization, inclusion dependencies • Practical query languages and integrity constraints w/o considering a conceptual domain model: SQL • Storage structures, database implementation architecture • Index structures • Query processing • Query optimization • Transactions and recovery • Query languages with recursion and consideration of a simple conceptual domain model: Datalog • Semi-naive evaluation strategy, magic sets transformation • Information integration, declarative schema transformation (LAV, GAV), distributed database systems • Description logics, syntax, semantics, decision problems, decision algorithms for Abox satisfiability • Ontology based data access (OBDA), DL-Lite for formalizing ER diagramms • Complexity measure: Data complexity • Semistructured databases and query languages: XML and XQuery
Literature	1. A. Kemper, A. Eickler, Datenbanksysteme - n. Auflage, Oldenbourg, 2010 2. S. Abiteboul, R. Hull, V. Vianu, Foundations of Databases, Addison-Wesley, 1995 3. Database Systems, An Application Oriented Approach, Pearson International Edition, 2005 4. H. Garcia-Molina, J.D. Ullman, J. Widom, Database Systems: The Complete Book, Prentice Hall, 2002

Course L1150: Databases	
Typ	Problem-based Learning
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	NN
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0651: Computational Geometry

Courses

Title	Typ	Hrs/wk	CP
Computational Geoemetry (L0393)	Lecture	2	4
Computational Geoemetry (L0394)	Recitation Section (small)	2	2

Module Responsible	Dr. Prashant Batra
Admission Requirements	None
Recommended Previous Knowledge	Linear algebra and analytic geometry as taught in higher secondary school (Computing with vectors a. determinants, Interpretation of scalar product, cross-product, Representation of lines/planes, Satz d. Pythagoras' theorem, cosine theorem, Thales' theorem, projections/embeddings) Basic data structures (trees, binary trees, search trees, balanced binary trees, linked lists) Definition of a graph
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can name the basic concepts of computer-assisted geometry, describe them with mathematical precision, and explain them by means of examples. Students are conversant with the computational description of geometrical (combinational/topological) facts, including determinant formulas and complexity assessments and proofs for all algorithms, especially output-sensitive algorithms. Students are able to discuss logical connections between these concepts and to explain them by means of examples.
Skills	Students can model tasks from computer-assisted geometry with the aid of the concepts about which they have learnt and can solve them by means of the methods they have learnt.
Personal Competence	
Social Competence	Students are able to discuss with other attendees their own algorithmic suggestions for solving the problems presented. They are also able to work in teams and are conversant with mathematics as a common language.
Autonomy	Students are capable of accessing independently further logical connections between the concepts about which they have learnt and are able to verify them.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Oral exam
Examination duration and scale	30 min
Assignment for the Following Curricula	Computer Science: Specialisation Computational Mathematics: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory

Course L0393: Computational Geoemetry

Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Dr. Prashant Batra
Language	DE
Cycle	WiSe
Content	Construction of the convex hull of n points, triangulation of a simple polygon Construction of Delaunay-triangulation and Voronoi-diagram Algorithms and data structures for the construction of arrangements, and Ham-Sandwich-Cuts. the intersection of half-planes, the optimization of a linear functional over the latter. Efficiente determination of all intersection of (orthogonal) lines (line segments) Approximative computation of the diameter of a point set Randomised incremental algorithms Basics of lattice point theory , LLL-algorithm and application in integer-valued optimization. Basics of motion planning
Literature	Computational Geometry Algorithms and Applications Authors:

- Prof. Dr. Mark de Berg,
- Dr. Otfried Cheong,
- Dr. Marc van Kreveld,
- Prof. Dr. Mark Overmars

Springer e-Book: http://dx.doi.org/10.1007/978-3-540-77974-2

	Algorithmische Geometrie : Grundlagen, Methoden, Anwendungen / Rolf Klein
Verfasser:	Klein, Rolf
Ausgabe:	2., vollst. überarb. Aufl.
Erschienen:	Berlin [u.a.] : Springer, 2005
Umfang:	XI, 392 S. : graph. Darst.

Springer e-Book: http://dx.doi.org/10.1007/3-540-27619-X

O'Rourke, Joseph
Computational geometry in C. (English) Zbl 0816.68124
Cambridge: Univ. Press. ix, 346 p. $ 24.95; £16.95 /sc; $ 59.95; £35.00 /hc (1994).

ISBN: 0-521-44034-3 ; 0-521-44592-2

	Computational geometry : an introduction / Franco P. Preparata; Michael Ian Shamos
Verfasser:	Preparata, Franco P. ; Shamos, Michael Ian
Ausgabe:	Corr. and expanded 2. printing.
Erschienen:	New York [u.a.] : Springer, 1988
Umfang:	XIV, 398 S. : graph. Darst.
Schriftenreihe:	Texts and monographs in computer science
ISBN:	3-540-96131-3 0-387-96131-3

Devadoss, Satyan L.; O'Rourke, Joseph
Discrete and computational geometry. (English) Zbl 1232.52001
Princeton, NJ: Princeton University Press (ISBN 978-0-691-14553-2/hbk; 978-1-400-83898-1/ebook). xi, 255 p.

ISBN: 978-3-540-77973-5 (Print) 978-3-540-77974-2 (Online)

Course L0394: Computational Geometry	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Prashant Batra
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1269: Lab Cyber-Physical Systems

Courses

Title	Typ	Hrs/wk	CP
Lab Cyber-Physical Systems (L1740)	Problem-based Learning	4	6

Module Responsible	Prof. Heiko Falk
Admission Requirements	None
Recommended Previous Knowledge	Module "Embedded Systems"
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Cyber-Physical Systems (CPS) are tightly integrated with their surrounding environment, via sensors, A/D and D/A converters, and actors. Due to their particular application areas, highly specialized sensors, processors and actors are common. Accordingly, there is a large variety of different specification approaches for CPS - in contrast to classical software engineering approaches. Based on practical experiments using robot kits and computers, the basics of specification and modelling of CPS are taught. The lab introduces into the area (basic notions, characteristical properties) and their specification techniques (models of computation, hierarchical automata, data flow models, petri nets, imperative approaches). Since CPS frequently perform control tasks, the lab's experiments will base on simple control applications. The experiments will use state-of-the-art industrial specification tools (MATLAB/Simulink, LabVIEW, NXC) in order to model cyber-physical models that interact with the environment via sensors and actors.
Skills	After successful attendance of the lab, students are able to develop simple CPS. They understand the interdependencies between a CPS and its surrounding processes which stem from the fact that a CPS interacts with the environment via sensors, A/D converters, digital processors, D/A converters and actors. The lab enables students to compare modelling approaches, to evaluate their advantages and limitations, and to decide which technique to use for a concrete task. They will be able to apply these techniques to practical problems. They obtain first experiences in hardware-related software development, in industry-relevant specification tools and in the area of simple control applications.
Personal Competence	
Social Competence	Students are able to solve similar problems alone or in a group and to present the results accordingly.
Autonomy	Students are able to acquire new knowledge from specific literature and to associate this knowledge with other classes.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Project
Examination duration and scale	Execution and documentation of all lab experiments
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Computer Science: Elective Compulsory Computer Science: Specialisation Computer and Software Engineering: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory Mechatronics: Specialisation Intelligent Systems and Robotics: Elective Compulsory Mechatronics: Specialisation System Design: Elective Compulsory Mechatronics: Technical Complementary Course: Elective Compulsory

Course L1740: Lab Cyber-Physical Systems

Typ	Problem-based Learning
Hrs/wk	4
CP	6
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Lecturer	Prof. Heiko Falk
Language	DE/EN
Cycle	SoSe
Content	• Experiment 1: Programming in NXC • Experiment 2: Programming the Robot in Matlab/Simulink • Experiment 3: Programming the Robot in LabVIEW
Literature	• Peter Marwedel. Embedded System Design - Embedded System Foundations of Cyber-Physical Systems. 2nd Edition, Springer, 2012. • Begleitende Foliensätze

Module M0754: Compiler Construction

Courses			
Title	**Typ**	**Hrs/wk**	**CP**
Compiler Construction (L0703)	Lecture	2	2
Compiler Construction (L0704)	Recitation Section (small)	2	4

Module Responsible	Prof. Sibylle Schupp
Admission Requirements	None
Recommended Previous Knowledge	• Practical programming experience • Automata theory and formal languages • Functional programming or procedural programming • Object-oriented programming, algorithms, and data structures • Basic knowledge of software engineering
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students explain the workings of a compiler and break down a compilation task in different phases. They apply and modify the major algorithms for compiler construction and code improvement. They can re-write those algorithms in a programming language, run and test them. They choose appropriate internal languages and representations and justify their choice. They explain and modify implementations of existing compiler frameworks and experiment with frameworks and tools.
Skills	Students design and implement arbitrary compilation phases. They integrate their code in existing compiler frameworks. They organize their compiler code properly as a software project. They generalize algorithms for compiler construction to algorithms that analyze or synthesize software.
Personal Competence	
Social Competence	Students develop the software in a team. They explain problems and solutions to their team members. They present and defend their software in class. They communicate in English.
Autonomy	Students develop their software independently and define milestones by themselves. They receive feedback throughout the entire project. They organize the software project so that they can assess their progress themselves.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Project
Examination duration and scale	Software (Compiler)
Assignment for the Following Curricula	Computer Science: Specialisation Computer and Software Engineering: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory

Course L0703: Compiler Construction

Typ	Lecture
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Sibylle Schupp
Language	EN
Cycle	SoSe
Content	• Lexical and syntactic analysis • Semantic analysis • High-level optimization • Intermediate languages and code generation • Compilation pipeline
Literature	Alfred Aho, Jeffrey Ullman, Ravi Sethi, and Monica S. Lam, Compilers: Principles, Techniques, and Tools, 2nd edition Aarne Ranta, Implementing Programming Languages, An Introduction to Compilers and Interpreters, with an appendix coauthored by Markus Forsberg, College Publications, London, 2012

Course L0704: Compiler Construction

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

Module M1062: Mathematical Statistics

Courses

Title	Typ	Hrs/wk	CP
Mathematical Statistics (L1339)	Lecture	3	4
Mathematical Statistics (L1340)	Recitation Section (small)	1	2

Module Responsible	Prof. Anusch Taraz
Admission Requirements	none
Recommended Previous Knowledge	Mathematical Stochastics Measure Theory and Stochastics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• Students can name the basic concepts in Mathematical Statistics. They are able to explain them using appropriate examples. • Students can discuss logical connections between these concepts. They are capable of illustrating these connections with the help of examples. • They know proof strategies and can reproduce them.
Skills	• Students can model problems in Mathematical Statistics with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods. • Students are able to discover and verify further logical connections between the concepts studied in the course. • For a given problem, the students can develop and execute a suitable approach, and are able to critically evaluate the results.
Personal Competence	
Social Competence	• Students are able to work together in teams. They are capable to use mathematics as a common language. • In doing so, they can communicate new concepts according to the needs of their cooperating partners. Moreover, they can design examples to check and deepen the understanding of their peers.
Autonomy	• Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them. • Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard problems.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Written exam
Examination duration and scale	120 minutes
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Computer Science: Elective Compulsory Computer Science: Specialisation Computational Mathematics: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Computer Science: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory Technomathematics: Specialisation I. Mathematics: Elective Compulsory

Course L1339: Mathematical Statistics

Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE/EN
Cycle	SoSe
Content	• Substitution and Maximum-Likelihood methods for construction of estimators • Optimal unfalsified estimators • Optimal tests for parametric probability distributions (Neymann-Pearson theory) • Sufficiency and completeness and their application to estimation and test problems • Tests in normal distribution (e.g. Student's test) • Confidence domains and test families
Literature	• V. K. Rohatgi and A. K. Ehsanes Saleh (2001). **An introduction to probability and statistics**. Wiley. • L. Wasserman (2010). **All of statistics : A concise course in statistical inference**. Springer. • H. Witting (1985). **Mathematische Statistik: Parametrische Verfahren bei festem Stichprobenumfang**. Teubner.

Course L1340: Mathematical Statistics	
Typ	Recitation Section (small)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE/EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0715: Solvers for Sparse Linear Systems

Courses

Title	Typ	Hrs/wk	CP
Solvers for Sparse Linear Systems (L0583)	Lecture	2	3
Solvers for Sparse Linear Systems (L0584)	Recitation Section (small)	2	3

Module Responsible	Prof. Sabine Le Borne
Admission Requirements	None
Recommended Previous Knowledge	• Mathematics I + II for Engineering students or Analysis & Lineare Algebra I + II for Technomathematicians • Programming experience in C
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can • list classical and modern iteration methods and their interrelationships, • repeat convergence statements for iteration methods, • explain aspects regarding the efficient implementation of iteration methods.
Skills	Students are able to • implement, test, and compare iterative methods, • analyse the convergence behaviour of iterative methods and, if applicable, compute congergence rates.
Personal Competence	
Social Competence	Students are able to • work together in heterogeneously composed teams (i.e., teams from different study programs and background knowledge), explain theoretical foundations and support each other with practical aspects regarding the implementation of algorithms.
Autonomy	Students are capable • to assess whether the supporting theoretical and practical excercises are better solved individually or in a team, • to work on complex problems over an extended period of time, • to assess their individual progess and, if necessary, to ask questions and seek help.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Oral exam
Examination duration and scale	20 min
Assignment for the Following Curricula	Computer Science: Specialisation Computational Mathematics: Elective Compulsory Electrical Engineering: Core qualification: Elective Compulsory Electrical Engineering: Specialisation Modeling and Simulation: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory Technomathematics: Specialisation I. Mathematics: Elective Compulsory

Course L0583: Solvers for Sparse Linear Systems

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Sabine Le Borne
Language	DE/EN
Cycle	SoSe
Content	1. Sparse systems: Orderings and storage formats, direct solvers 2. Classical methods: basic notions, convergence 3. Projection methods 4. Krylov space methods 5. Preconditioning (e.g. ILU) 6. Multigrid methods
Literature	1. Y. Saad, Iterative methods for sparse linear systems

Course L0584: Solvers for Sparse Linear Systems

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

Module M0634: Introduction into Medical Technology and Systems

Courses			
Title	**Typ**	**Hrs/wk**	**CP**
Introduction into Medical Technology and Systems (L0342)	Lecture	2	3
Introduction into Medical Technology and Systems (L0343)	Project Seminar	2	2
Introduction into Medical Technology and Systems (L1876)	Recitation Section (large)	1	1

Module Responsible	Prof. Alexander Schlaefer
Admission Requirements	none
Recommended Previous Knowledge	principles of math (algebra, analysis/calculus) principles of stochastics principles of programming, R/Matlab
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can explain principles of medical technology, including imaging systems, computer aided surgery, and medical information systems. They are able to give an overview of regulatory affairs and standards in medical technology.
Skills	The students are able to evaluate systems and medical devices in the context of clinical applications.
Personal Competence	
Social Competence	The students describe a problem in medical technology as a project, and define tasks that are solved in a joint effort.
Autonomy	The students can reflect their knowledge and document the results of their work. They can present the results in an appropriate manner.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Examination	Written exam
Examination duration and scale	90 minutes
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory Computer Science: Specialisation Computer and Software Engineering: Elective Compulsory Electrical Engineering: Core qualification: Elective Compulsory General Engineering Science (English program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0342: Introduction into Medical Technology and Systems

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	DE
Cycle	SoSe
Content	- imaging systems - computer aided surgery - medical sensor systems - medical information systems - regulatory affairs - standard in medical technology The students will work in groups to apply the methods introduced during the lecture using problem based learning.
Literature	Wird in der Veranstaltung bekannt gegeben.

Course L0343: Introduction into Medical Technology and Systems

Typ	Project Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1876: Introduction into Medical Technology and Systems	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Alexander Schlaefer
Language	DE
Cycle	SoSe
Content	
Literature	

Module M1300: Software Development

Courses			
Title	**Typ**	**Hrs/wk**	**CP**
Software Development (L1790)	Problem-based Learning	2	5
Software Development (L1789)	Lecture	1	1

Module Responsible	Prof. Sibylle Schupp
Admission Requirements	None
Recommended Previous Knowledge	• Introduction to Software Engineering • Programming Skills • Experience with Developing Small to Medium-Size Programs
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students explain the fundamental concepts of agile methods, describe the process of test-driven development, and explain how continuous integration can be used in different scenarios. They give examples of selected pitfalls in software development, regarding scalability and other non-functional requirements. They write unit tests and build scripts and combine them in a corresponding integration environment. They explain major activities in requirements analysis, program comprehension, and agile project development.
Skills	For a given task on a legacy system, students identify the corresponding parts in the system and select an appropriate method for understanding the details. They choose the proper approach of splitting a task in independent testable and extensible pieces and, thus, solve the task with proper methods for quality assurance. They design tests for legacy systems, create automated builds, and find errors at different levels. They integrate the resulting artifacts in a continuous development environment
Personal Competence	
Social Competence	Students discuss different design decisions in a group. They defend their solutions orally. They communicate in English.
Autonomy	Using accompanying tools, students can assess their level of knowledge continuously and adjust it appropriately. Within limits, they can set their own learning goals. Upon su completion, students can identify and formulate concrete problems of software systems and propose solutions. Within this field, they can conduct independent studies to acc necessary competencies. They can devise plans to arrive at new solutions or assess existing ones.
Workload in Hours	Independent Study Time 138, Study Time in Lecture 42
Credit points	6
Examination	Project
Examination duration and scale	Software
Assignment for the Following Curricula	Computer Science: Specialisation Computer and Software Engineering: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory

Course L1790: Software Development	
Typ	Problem-based Learning
Hrs/wk	2
CP	5
Workload in Hours	Independent Study Time 122, Study Time in Lecture 28
Lecturer	Prof. Sibylle Schupp
Language	EN
Cycle	SoSe
Content	• Agile Methods • Test-Driven Development and Unit Testing • Continuous Integration • Web Services • Scalability • From Defects to Failure
Literature	Duvall, Paul M. Continuous Integration. Pearson Education India, 2007. Humble, Jez, and David Farley. Continuous delivery: reliable software releases through build, test, and deployment automation. Pearson Education, 2010. Martin, Robert Cecil. Agile software development: principles, patterns, and practices. Prentice Hall PTR, 2003. http://scrum-kompakt.de/ Myers, Glenford J., Corey Sandler, and Tom Badgett. The art of software testing. John Wiley & Sons, 2011.

Course L1789: Software Development	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Sibylle Schupp
Language	EN
Cycle	SoSe
Content	• Agile Methods • Test-Driven Development and Unit Testing • Continuous Integration • Web Services • Scalability • From Defects to Failure
Literature	Duvall, Paul M. Continuous Integration. Pearson Education India, 2007. Humble, Jez, and David Farley. Continuous delivery: reliable software releases through build, test, and deployment automation. Pearson Education, 2010. Martin, Robert Cecil. Agile software development: principles, patterns, and practices. Prentice Hall PTR, 2003. http://scrum-kompakt.de/ Myers, Glenford J., Corey Sandler, and Tom Badgett. The art of software testing. John Wiley & Sons, 2011.

Specialization Engineering Sciences

Module M0671: Technical Thermodynamics I

Courses

Title	Typ	Hrs/wk	CP
Technical Thermodynamics I (L0437)	Lecture	2	4
Technical Thermodynamics I (L0439)	Recitation Section (large)	1	1
Technical Thermodynamics I (L0441)	Recitation Section (small)	1	1

Module Responsible	Prof. Gerhard Schmitz
Admission Requirements	none
Recommended Previous Knowledge	Elementary knowledge in Mathematics and Mechanics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are familiar with the laws of Thermodynamics. They know the relation of the kinds of energy according to 1st law of Thermodynamics and are aware about the limits of energy conversions according to 2nd law of Thermodynamics. They are able to distinguish between state variables and process variables and know the meaning of different state variables like temperature, enthalpy, entropy and also the meaning of exergy and anergy. They are able to draw the Carnot cycle in a Thermodynamics related diagram. They know the physical difference between an ideal and a real gas and are able to use the related equations of state. They know the meaning of a fundamental state of equation and know the basics of two phase Thermodynamics.
Skills	Students are able to calculate the internal energy, the enthalpy, the kinetic and the potential energy as well as work and heat for simple change of states and to use this calculations for the Carnot cycle. They are able to calculate state variables for an ideal and for a real gas from measured thermal state variables.
Personal Competence	
Social Competence	The students are able to discuss in small groups and develop an approach.
Autonomy	Students are able to define independently tasks, to get new knowledge from existing knowledge as well as to find ways to use the knowledge in practice.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	General Engineering Science (German program): Core qualification: Compulsory General Engineering Science (German program, 7 semester): Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program): Core qualification: Compulsory General Engineering Science (English program, 7 semester): Core qualification: Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Naval Architecture: Core qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Process Engineering: Core qualification: Compulsory

Course L0437: Technical Thermodynamics I	
Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Gerhard Schmitz
Language	DE
Cycle	SoSe
Content	1. Introduction 2. Fundamental terms 3. Thermal Equilibrium and temperature 3.1 Thermal equation of state 4. First law 4.1 Heat and work 4.2 First law for closed systems 4.3 First law for open systems 4.4 Examples 5. Equations of state and changes of state 5.1 Changes of state 5.2 Cycle processes 6. Second law 6.1 Carnot process 6.2 Entropy 6.3 Examples 6.4 Exergy 7. Thermodynamic properties of pure fluids 7.1 Fundamental equations of Thermodynamics 7.2 Thermodynamic potentials 7.3 Calorific state variables for arbritary fluids 7.4 state equations (van der Waals u.a.)
Literature	• Schmitz, G.: Technische Thermodynamik, TuTech Verlag, Hamburg, 2009 • Baehr, H.D.; Kabelac, S.: Thermodynamik, 15. Auflage, Springer Verlag, Berlin 2012 • Potter, M.; Somerton, C.: Thermodynamics for Engineers, Mc GrawHill, 1993

Course L0439: Technical Thermodynamics I	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Gerhard Schmitz
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L0441: Technical Thermodynamics I	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Gerhard Schmitz
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0854: Mathematics IV

Courses

Title	Typ	Hrs/wk	CP
Differential Equations 2 (Partial Differential Equations) (L1043)	Lecture	2	1
Differential Equations 2 (Partial Differential Equations) (L1044)	Recitation Section (small)	1	1
Differential Equations 2 (Partial Differential Equations) (L1045)	Recitation Section (large)	1	1
Complex Functions (L1038)	Lecture	2	1
Complex Functions (L1041)	Recitation Section (small)	1	1
Complex Functions (L1042)	Recitation Section (large)	1	1

Module Responsible: Prof. Anusch Taraz

Admission Requirements: none

Recommended Previous Knowledge: Mathematics 1 - III

Educational Objectives: After taking part successfully, students have reached the following learning results

Professional Competence

Knowledge

- Students can name the basic concepts in Mathematics IV. They are able to explain them using appropriate examples.
- Students can discuss logical connections between these concepts. They are capable of illustrating these connections with the help of examples.
- They know proof strategies and can reproduce them.

Skills

- Students can model problems in Mathematics IV with the help of the concepts studied in this course. Moreover, they are capable of solving them by applying established methods.
- Students are able to discover and verify further logical connections between the concepts studied in the course.
- For a given problem, the students can develop and execute a suitable approach, and are able to critically evaluate the results.

Personal Competence

Social Competence

- Students are able to work together in teams. They are capable to use mathematics as a common language.
- In doing so, they can communicate new concepts according to the needs of their cooperating partners. Moreover, they can design examples to check and deepen the understanding of their peers.

Autonomy

- Students are capable of checking their understanding of complex concepts on their own. They can specify open questions precisely and know where to get help in solving them.
- Students have developed sufficient persistence to be able to work for longer periods in a goal-oriented manner on hard problems.

Workload in Hours: Independent Study Time 68, Study Time in Lecture 112

Credit points: 6

Examination: Written exam

Examination duration and scale: 60 min (Complex Functions) + 60 min (Differential Equations 2)

Assignment for the Following Curricula:

General Engineering Science (German program): Specialisation Electrical Engineering: Compulsory
General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory
General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory
General Engineering Science (German program): Specialisation Naval Architecture: Compulsory
General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory
General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory
General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory
General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory
Computer Science: Specialisation Computational Mathematics: Elective Compulsory
Electrical Engineering: Core qualification: Compulsory
General Engineering Science (English program): Specialisation Electrical Engineering: Compulsory
General Engineering Science (English program): Specialisation Naval Architecture: Compulsory
General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory
General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Theoretical Mechanical Engineering: Compulsory
General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory
Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory
Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory
Mechanical Engineering: Specialisation Theoretical Mechanical Engineering: Compulsory
Mechanical Engineering: Specialisation Mechatronics: Compulsory
Mechatronics: Core qualification: Compulsory
Naval Architecture: Core qualification: Compulsory
Theoretical Mechanical Engineering: Technical Complementary Course Core Studies: Elective Compulsory

Course L1043: Differential Equations 2 (Partial Differential Equations)	
Typ	Lecture
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	Main features of the theory and numerical treatment of partial differential equations • Examples of partial differential equations • First order quasilinear differential equations • Normal forms of second order differential equations • Harmonic functions and maximum principle • Maximum principle for the heat equation • Wave equation • Liouville's formula • Special functions • Difference methods • Finite elements
Literature	• http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html

Course L1044: Differential Equations 2 (Partial Differential Equations)	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1045: Differential Equations 2 (Partial Differential Equations)	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1038: Complex Functions	
Typ	Lecture
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	Main features of complex analysis • Functions of one complex variable • Complex differentiation • Conformal mappings • Complex integration • Cauchy's integral theorem • Cauchy's integral formula • Taylor and Laurent series expansion • Singularities and residuals • Integral transformations: Fourier and Laplace transformation
Literature	• http://www.math.uni-hamburg.de/teaching/export/tuhh/index.html

Course L1041: Complex Functions	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1042: Complex Functions	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dozenten des Fachbereiches Mathematik der UHH
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0688: Technical Thermodynamics II

Courses

Title	Typ	Hrs/wk	CP
Technical Thermodynamics II (L0449)	Lecture	2	4
Technical Thermodynamics II (L0450)	Recitation Section (large)	1	1
Technical Thermodynamics II (L0451)	Recitation Section (small)	1	1

Module Responsible	Prof. Gerhard Schmitz
Admission Requirements	none
Recommended Previous Knowledge	Elementary knowledge in Mathematics, Mechanics and Technical Thermodynamics I
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are familiar with different cycle processes like Joule, Otto, Diesel, Stirling, Seiliger and Clausius-Rankine. They are able to derive energetic and exergetic efficiencies and know the influence different factors. They know the difference between anti clockwise and clockwise cycles (heat-power cycle, cooling cycle). They have increased knowledge of steam cycles and are able to draw the different cycles in Thermodynamics related diagrams. They know the laws of gas mixtures, especially of humid air processes and are able to perform simple combustion calculations. They are provided with basic knowledge in gas dynamics and know the definition of the speed of sound and know about a Laval nozzle.
Skills	Students are able to use thermodynamic laws for the design of technical processes. Especially they are able to formulate energy, exergy- and entropy balances and by this to optimise technical processes. They are able to perform simple safety calculations in regard to an outflowing gas from a tank. They are able to transform a verbal formulated message into an abstract formal procedure.
Personal Competence	
Social Competence	The students are able to discuss in small groups and develop an approach.
Autonomy	Students are able to define independently tasks, to get new knowledge from existing knowledge as well as to find ways to use the knowledge in practice.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	General Engineering Science (German program): Core qualification: Compulsory General Engineering Science (German program, 7 semester): Core qualification: Compulsory Bioprocess Engineering: Core qualification: Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program): Core qualification: Compulsory General Engineering Science (English program, 7 semester): Core qualification: Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory Mechanical Engineering: Core qualification: Compulsory Mechatronics: Core qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Technomathematics: Core qualification: Elective Compulsory Technomathematics: Core qualification: Elective Compulsory Process Engineering: Core qualification: Compulsory

Course L0449: Technical Thermodynamics II	
Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Prof. Gerhard Schmitz
Language	DE
Cycle	WiSe
Content	8. Cycle processes 7. Gas - vapor - mixtures 10. Open sytems with constant flow rates 11. Combustion processes 12. Special fields of Thermodynamics
Literature	• Schmitz, G.: Technische Thermodynamik, TuTech Verlag, Hamburg, 2009 • Baehr, H.D.; Kabelac, S.: Thermodynamik, 15. Auflage, Springer Verlag, Berlin 2012 • Potter, M.; Somerton, C.: Thermodynamics for Engineers, Mc GrawHill, 1993

Course L0450: Technical Thermodynamics II	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Gerhard Schmitz
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L0451: Technical Thermodynamics II	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Gerhard Schmitz
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M0675: Introduction to Communications and Random Processes

Courses

Title	Typ	Hrs/wk	CP
Introduction to Communications and Random Processes (L0442)	Lecture	3	4
Introduction to Communications and Random Processes (L0443)	Recitation Section (large)	1	2

Module Responsible	Prof. Gerhard Bauch
Admission Requirements	None
Recommended Previous Knowledge	• Mathematics 1-3 • Signals and Systems • Basic knowledge of probability theory
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students know and understand the fundamental building blocks of a communications system. They can describe and analyse the individual building blocks using knowledge of signal and system theory as well as the theory of stochastic processes. The are aware of the essential resources and evaluation criteria of information transmission and are able to design and evaluate a basic communications system.
Skills	The students are able to design and evaluate a basic communications system. In particular, they can estimate the required resources in terms of bandwidth and power. They are able to assess essential evaluation parameters of a basic communications system such as bandwidth efficiency or bit error rate and to decide for a suitable transmission method.
Personal Competence	
Social Competence	The students can jointly solve specific problems.
Autonomy	The students are able to acquire relevant information from appropriate literature sources. They can control their level of knowledge during the lecture period by solving tutorial problems, software tools, clicker system.
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory Computer Science: Specialisation Computer and Software Engineering: Elective Compulsory Electrical Engineering: Core qualification: Compulsory General Engineering Science (English program): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Technomathematics: Core qualification: Elective Compulsory

Course L0442: Introduction to Communications and Random Processes	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Gerhard Bauch
Language	DE/EN
Cycle	WiSe
Content	• Fundamentals of random processes • Introduction to communications engineering • Quadrature amplitude modulation • Description of radio frequency transmission in the equivalent complex baseband • Transmission channels, channel models • Analog digital conversion: Sampling, quantization, pulsecode modulation (PCM) • Fundamentals of information theory, source coding, channel coding • Digital baseband transmission: Pulse shaping, eye diagramm, 1. and 2. Nyquist condition, matched filter, detection, error probability • Fundamentals of digital modulation
Literature	K. Kammeyer: Nachrichtenübertragung, Teubner P.A. Höher: Grundlagen der digitalen Informationsübertragung, Teubner. M. Bossert: Einführung in die Nachrichtentechnik, Oldenbourg. J.G. Proakis, M. Salehi: Grundlagen der Kommunikationstechnik. Pearson Studium. J.G. Proakis, M. Salehi: Digital Communications. McGraw-Hill. S. Haykin: Communication Systems. Wiley J.G. Proakis, M. Salehi: Communication Systems Engineering. Prentice-Hall. J.G. Proakis, M. Salehi, G. Bauch, Contemporary Communication Systems. Cengage Learning.

Course L0443: Introduction to Communications and Random Processes	
Typ	Recitation Section (large)
Hrs/wk	1
CP	2
Workload in Hours	Independent Study Time 46, Study Time in Lecture 14
Lecturer	Prof. Gerhard Bauch
Language	DE/EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1105: Mechanics III (GES)

Courses			
Title	**Typ**	**Hrs/wk**	**CP**
Mechanics III (GES) (L1421)	Lecture	3	3
Mechanics III (GES) (L1420)	Recitation Section (small)	2	2
Mechanics III (GES) (L1419)	Recitation Section (large)	1	1

Module Responsible	Prof. Radoslaw Iwankiewicz
Admission Requirements	None
Recommended Previous Knowledge	None
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The primary purpose of the study of Mechanics III (Fluid Statics, Kinematics and Kinetics) is to develop the capacity to predict the effects of forces and motions, necessary for the analysis and design of moving machine parts, different machinery, vehicles, aircraft, spacecraft, automatic control systems, etc.The particular objectives of this course are to: 1. Determine the hydrostatic forces acting on different objects. 2. Analyse stability of floating bodies. 3. Analyse the kinematics and kinetics of a particle in different reference systems, 4. Analyse the motion of the system of particles and forces acting on it, 5. Analyse the plane motion of a rigid body (simple mechanism) and forces acting on it. 6. Analyse the three-dimensional motion of a rigid body and forces acting on it.
Skills	At the end of this course the student should be able to: 1. Solve the equilibrium problems with account for hydrostatic pressure forces. 2. Analyse stability of simple floating bodies. 3. Calculate the velocity and acceleration of a particle in different reference systems. • 4. Derive and solve the equation of motion of a particle in different reference systems. 5. Analyse the motion of the system of particles and forces acting on it with the aid of work-energy and impulse-momentum relationships, 6. Calculate the instantaneous linear and angular velocities and accelerations of the planar mechanisms. 7. Derive and solve the equations of a plane motion of a rigid body and find forces acting on it, 8. Apply work-energy and impulse-momentum relationships to analyse plane kinetics of a rigid body. 9. Calculate the instantaneous linear and angular velocities and accelerations of the three-dimensional motion of a rigid body. 10. Derive the equations of a motion of a three-dimensional motion of a rigid body. 11. Apply in three-dimensional kinematics and kinetics of rigid body both methods of vector algebra and matrix methods.
Personal Competence	
Social Competence	Students can: - work in groups and report on the findings, - develop joint solutions in mixed teams and present them to others, - assess the team collaboration and their share in it.
Autonomy	Students are able to: -solve the problems independently with the help of hints, - assess their own strengths and weaknesses, e.g. with the aid of the mid-term test.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Examination	Written exam
Examination duration and scale	2 hours Fluid Statics: hydrostatic pressure, buoyancy, stability of floating vessels. Kinematics of particle, of plane and 3D rigid bod,y. Kinetics of particle, system of particles, of plane and 3D rigid body. Vector and matrix algebra formulation.
Assignment for the Following Curricula	General Engineering Science (English program): Core qualification: Compulsory General Engineering Science (English program, 7 semester): Core qualification: Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory

Course L1421: Mechanics III (GES)

Typ	Lecture
Hrs/wk	3
CP	3
Workload in Hours	Independent Study Time 48, Study Time in Lecture 42
Lecturer	Prof. Radoslaw Iwankiewicz
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1420: Mechanics III (GES)	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Radoslaw Iwankiewicz
Language	EN
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Course L1419: Mechanics III (GES)	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Radoslaw Iwankiewicz
Language	EN
Cycle	WiSe
Content	FLUID STATICS 1. Fluid pressure, hydrostatic pressure on flat and cylindrical surfaces. 2. Buoyancy force, buoyancy center, metacenter, stability of floating objects. KINEMATICS 1. Kinematics of a particle. Plane curvilinear motion: rectangular coordinates, normal and tangential coordinates, polar coordinates. Space curvilinear motion. 2. Constrained motion of connected particles. 3. Plane kinematics of a rigid body. 4. Relative (compound) motion. 5. Three-dimensional kinematics of a rigid body. KINETICS 1. Kinetics of a particle and of a system of particles. 2. Plane kinetics of a rigid body. 3. Three-dimensional kinetics of a rigid body.
Literature	1. J.L. Meriam and L.G, Kraige, Engineering Mechanics, Vol. 2, Dynamics, John Wiley & Sons, SI Version, 4th Edition 2 . R.C. Hibbeler, Engineering Mechanics, Dynamics, Pearson, Prentice Hall, SI 3rd Edition

Module M0708: Electrical Engineering III: Circuit Theory and Transients

Courses

Title	Typ	Hrs/wk	CP
Circuit Theory (L0566)	Lecture	3	4
Circuit Theory (L0567)	Recitation Section (small)	2	2

Module Responsible	Prof. Arne Jacob
Admission Requirements	none
Recommended Previous Knowledge	Electrical Engineering I and II, Mathematics I and II
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to explain the basic methods for calculating electrical circuits. They know the Fourier series analysis of linear networks driven by periodic signals. They know the methods for transient analysis of linear networks in time and in frequency domain, and they are able to explain the frequency behaviour and the synthesis of passive two-terminal-circuits.
Skills	The students are able to calculate currents and voltages in linear networks by means of basic methods, also when driven by periodic signals. They are able to calculate transients in electrical circuits in time and frequency domain and are able to explain the respective transient behaviour. They are able to analyse and to synthesize the frequency behaviour of passive two-terminal-circuits.
Personal Competence	
Social Competence	Students work on exercise tasks in small guided groups. They are encouraged to present and discuss their results within the group.
Autonomy	The students are able to find out the required methods for solving the given practice problems. Possibilities are given to test their knowledge during the lectures continuously by means of short-time tests. This allows them to control independently their educational objectives. They can link their gained knowledge to other courses like Electrical Engineering I and Mathematics I.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Examination	Written exam
Examination duration and scale	150 min
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory Electrical Engineering: Core qualification: Compulsory General Engineering Science (English program): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering, Focus Mechatronics: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory Mechatronics: Core qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0566: Circuit Theory	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Arne Jacob
Language	DE
Cycle	WiSe
Content	- Circuit theorems - N-port circuits - Periodic excitation of linear circuits - Transient analysis in time domain - Transient analysis in frequency domain; Laplace Transform - Frequency behaviour of passive one-ports
Literature	- M. Albach, "Grundlagen der Elektrotechnik 1", Pearson Studium (2011) - M. Albach, "Grundlagen der Elektrotechnik 2", Pearson Studium (2011) - L. P. Schmidt, G. Schaller, S. Martius, "Grundlagen der Elektrotechnik 3", Pearson Studium (2011) - T. Harriehausen, D. Schwarzenau, "Moeller Grundlagen der Elektrotechnik", Springer (2013) - A. Hambley, "Electrical Engineering: Principles and Applications", Pearson (2008) - R. C. Dorf, J. A. Svoboda, "Introduction to electrical circuits", Wiley (2006) - L. Moura, I. Darwazeh, "Introduction to Linear Circuit Analysis and Modeling", Amsterdam Newnes (2005)

Course L0567: Circuit Theory	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Arne Jacob
Language	DE
Cycle	WiSe
Content	see interlocking course
Literature	siehe korrespondierende Lehrveranstaltung see interlocking course

Module M0783: Measurements: Methods and Data Processing

Courses

Title	Typ	Hrs/wk	CP
EE Experimental Lab (L0781)	Laboratory Course	2	2
Measurements: Methods and Data Processing (L0779)	Lecture	2	3
Measurements: Methods and Data Processing (L0780)	Recitation Section (small)	1	1

Module Responsible	Prof. Alexander Schlaefer
Admission Requirements	none
Recommended Previous Knowledge	principles of mathematics principles of electrical engineering
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students are able to explain the purpose of metrology and the acquisition and processing of measurements. They can detail aspects of probability theory and errors, and explain the processing of stochastic signals. Students know methods to digitalize and describe measured signals.
Skills	The students are able to evaluate problems of metrology and to apply methods for describing and processing of measurements.
Personal Competence	
Social Competence	The students solve problems in small groups.
Autonomy	The students can reflect their knowledge and discuss and evaluate their results.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Examination	Written exam
Examination duration and scale	90 min
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Elective Compulsory Computer Science: Specialisation Computer and Software Engineering: Elective Compulsory Electrical Engineering: Core qualification: Compulsory General Engineering Science (English program): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Elective Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Technomathematics: Core qualification: Elective Compulsory

Course L0781: EE Experimental Lab

Typ	Laboratory Course
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer, Prof. Christian Schuster, Prof. Günter Ackermann, Prof. Rolf-Rainer Grigat, Prof. Arne Jacob, Prof. Herbert Werner, Dozenten des SD E, Prof. Heiko Falk
Language	DE
Cycle	WiSe
Content	lab experiments: digital circuits, semiconductors, micro controllers, analog circuits, AC power, electrical machines
Literature	Wird in der Lehrveranstaltung festgelegt

Course L0779: Measurements: Methods and Data Processing

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	DE
Cycle	WiSe
Content	introduction, systems and errors in metrology, probability theory, measuring stochastic signals, describing measurements, acquisition of analog signals, applied metrology
Literature	Puente León, Kiencke: Messtechnik, Springer 2012 Lerch: Elektrische Messtechnik, Springer 2012 Weitere Literatur wird in der Veranstaltung bekanntgegeben.

Course L0780: Measurements: Methods and Data Processing	
Typ	Recitation Section (small)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Alexander Schlaefer
Language	DE
Cycle	WiSe
Content	See interlocking course
Literature	See interlocking course

Module M1235: Electrical Power Systems I

Courses

Title	Typ	Hrs/wk	CP
Electrical Power Systems I (L1670)	Lecture	3	4
Electrical Power Systems I (L1671)	Recitation Section (large)	2	2

Module Responsible	Prof. Christian Becker
Admission Requirements	none
Recommended Previous Knowledge	Fundamentals of Electrical Engineering
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students are able to give an overview of conventional and modern electric power systems. They can explain in detail and critically evaluate technologies of electric power generation, transmission, storage, and distribution as well as integration of equipment into electric power systems.
Skills	With completion of this module the students are able to apply the acquired skills in applications of the design, integration, development of electric power systems and to assess the results.
Personal Competence	
Social Competence	The students can participate in specialized and interdisciplinary discussions, advance ideas and represent their own work results in front of others.
Autonomy	Students can independently tap knowledge of the emphasis of the lectures.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Examination	Written exam
Examination duration and scale	90 - 150 minutes
Assignment for the Following Curricula	General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Elective Compulsory Electrical Engineering: Core qualification: Elective Compulsory Energy and Environmental Engineering: Specialisation Energy Engineering: Elective Compulsory Energy Systems: Specialisation Energy Systems: Elective Compulsory Energy Systems: Specialisation Energy Systems: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Elective Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory Renewable Energies: Core qualification: Compulsory

Course L1670: Electrical Power Systems I	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Christian Becker
Language	DE
Cycle	WiSe

Content	• fundamentals and current development trends in electric power engineering
	• tasks and history of electric power systems
	• symmetric three-phase systems
	• fundamentals and modelling of eletric power systems
	    ◦ lines
	    ◦ transformers
	    ◦ synchronous machines
	    ◦ grid structures and substations
	• fundamentals of energy conversion
	    ◦ electro-mechanical energy conversion
	    ◦ thermodynamics
	    ◦ power station technology
	    ◦ renewable energy conversion systems
	• on-board electrical power systems
	• steady-state network calculation
	    ◦ network modelling
	    ◦ load flow calculation
	    ◦ (n-1)-criterion
	• symmetric failure calculations, short-circuit power
	• asymmetric failure calculation
	    ◦ symmetric components
	    ◦ calculation of asymmetric failures
	• control in networks and power stations
	• insulation coordination and protection
	• grid planning
	• power economy fundamentals

Literature	K. Heuck, K.-D. Dettmann, D. Schulz: "Elektrische Energieversorgung", Vieweg + Teubner, 9. Auflage, 2014 A. J. Schwab: "Elektroenergiesysteme", Springer, 3. Auflage, 2012 R. Flosdorff: "Elektrische Energieverteilung" Vieweg + Teubner, 9. Auflage, 2005

Course L1671: Electrical Power Systems I	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Christian Becker
Language	DE
Cycle	WiSe

Content	• fundamentals and current development trends in electric power engineering
	• tasks and history of electric power systems
	• symmetric three-phase systems
	• fundamentals and modelling of eletric power systems
	    ◦ lines
	    ◦ transformers
	    ◦ synchronous machines
	    ◦ grid structures and substations
	• fundamentals of energy conversion
	    ◦ electro-mechanical energy conversion
	    ◦ thermodynamics
	    ◦ power station technology
	    ◦ renewable energy conversion systems
	• on-board electrical power systems
	• steady-state network calculation
	    ◦ network modelling
	    ◦ load flow calculation
	    ◦ (n-1)-criterion
	• symmetric failure calculations, short-circuit power
	• asymmetric failure calculation
	    ◦ symmetric components
	    ◦ calculation of asymmetric failures
	• control in networks and power stations
	• insulation coordination and protection
	• grid planning
	• power economy fundamentals

Literature	K. Heuck, K.-D. Dettmann, D. Schulz: "Elektrische Energieversorgung", Vieweg + Teubner, 9. Auflage, 2014 A. J. Schwab: "Elektroenergiesysteme", Springer, 3. Auflage, 2012 R. Flosdorff: "Elektrische Energieverteilung" Vieweg + Teubner, 9. Auflage, 2005

Module M0680: Fluid Dynamics

Courses

Title	Typ	Hrs/wk	CP
Fluid Mechanics (L0454)	Lecture	3	4
Fluid Mechanics (L0455)	Recitation Section (large)	2	2

Module Responsible	Prof. Thomas Rung
Admission Requirements	none
Recommended Previous Knowledge	Sound knowledge of engineering mathematics, engineering mechanics and thermodynamics.
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students will have the required sound knowledge to explain the general principles of fluid engineering and physics of fluids. Students can scientifically outline the rationale of flow physics using mathematical models and are familiar with methods for the performance analysis and the prediciton of fluid engineering devices.
Skills	Students are able to apply fluid-engineering principles and flow-physics models for the analysis of technical systems. The lecture enables the student to carry out all necessary theoretical calculations for the fluid dynamic design of engineering devices on a scientific level.
Personal Competence	
Social Competence	The students are able to discuss problems and jointly develop solution strategies.
Autonomy	The students are able to develop solution strategies for complex problems self-consistent and crtically analyse results.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Examination	Written exam
Examination duration and scale	180 min
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program): Specialisation Naval Architecture: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Naval Architecture: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering: Compulsory General Engineering Science (English program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program): Specialisation Naval Architecture: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Naval Architecture: Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory Mechanical Engineering: Core qualification: Compulsory Naval Architecture: Core qualification: Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0454: Fluid Mechanics

Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	Prof. Thomas Rung
Language	DE
Cycle	SoSe
Content	• Overview • Physical/mathematical modelling • Special phenomena • Basic equations of fluid dynamics • The turbulence problem • One dimensional theory for inkompressibel flows • One dimensional theory for kompressibel flows • Flow over contours without friction • Flow over contours with friction • Flow through channels • Simplified equations for three dimensional flow • Special aspects of the numerical solution for complex flows
Literature	• Herwig, H.: Strömungsmechanik, 2. Auflage, Springer- Verlag, Berlin, Heidelberg, 2006 • Herwig, H.: Strömungsmechanik von A-Z, Vieweg Verlag, Wiesbaden, 2004

Course L0455: Fluid Mechanics	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Thomas Rung
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0748: Materials in Electrical Engineering

Courses

Title	Typ	Hrs/wk	CP
Electrotechnical Experiments (L0714)	Lecture	1	1
Materials in Electrical Engineering (L0685)	Lecture	2	3
Materials in Electrical Engineering (Problem Solving Course) (L0687)	Recitation Section (small)	2	2

Module Responsible	Prof. Manfred Eich
Admission Requirements	None
Recommended Previous Knowledge	Highschool level physics and mathematics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can explain the composition and the structural properties of materials used in electrical engineering. Students can explicate the relevance of mechanical, electrical, thermal, dielectric, magnetic and chemical properties of materials in view of their applications in electrical engineering.
Skills	Students can identify appropriate descriptive models and apply them mathematically. They can derive approximative solutions and judge factors influential on the performance of materials in electrical engineering applications.
Personal Competence	
Social Competence	Students can jointly solve subject related problems in groups. They can present their results effectively within the framework of the problem solving course.
Autonomy	Students are capable to extract relevant information from the provided references and to relate this information to the content of the lecture. They can reflect their acquired level of expertise with the help of lecture accompanying measures such as exam typical exam questions. Students are able to connect their knowledge with that acquired from other lectures.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Examination	Written exam
Examination duration and scale	60 minutes
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory Electrical Engineering: Core qualification: Compulsory General Engineering Science (English program): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory

Course L0714: Electrotechnical Experiments	
Typ	Lecture
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Dr. Wieland Hingst
Language	DE
Cycle	SoSe
Content	Agenda: - Natural sources of electricity - Oscilloscope - Characterizing signals - 2 terminal circuit elements - 2-ports - Power - Matching - Inductive coupling - Resonance - Radio frequencies - Transistor circuits - Electrical measurement - Materials for the EE - Electrical fun
Literature	Tietze, Schenk: "Halbleiterschaltungstechnik", Springer

Course L0685: Materials in Electrical Engineering	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Manfred Eich
Language	DE
Cycle	SoSe
Content	The Hamiltonian approach to classical mechanics. Analysis of a simple oscillator. Analysis of vibrations in a one-dimensional lattice. Phononic bandgap Introduction to quantum mechanics Wave function, Schrödinger's equation, observables and measurements. Quantum mechanical harmonic oscillator and spectral decomposition. Symmetries, conserved quantities, and the labeling of states. Angular momentum The hydrogen atom Waves in periodic potentials Reciprocal lattice and reciprocal lattice vectors Band gap Band diagrams The free electron gas and the density of states Fermi-Dirac distribution Density of charge carriers in semiconductors Conductivity in semiconductors. Engineering conductivity through doping. The P-N junction (diode) Light emitting diodes Electromagnetic waves interacting with materials Reflection and refraction Photonic band gaps Origins of magnetization Hysteresis in ferromagnetic materials Magnetic domains
Literature	1.Anikeeva, Beach, Holten-Andersen, Fink, Electronic, Optical and Magnetic Properties of Materials, Massachusetts Institute of Technology (MIT), 2013 2.Hagelstein et al., Introductory Applied Quantum and Statistical Mechanics, Wiley 2004 3.Griffiths, Introduction to Quantum Mechanics, Prentice Hall, 1994 4.Shankar, Principles of Quantum Mechanics, 2nd ed., Plenum Press, 1994 5.Fick, Einführung in die Grundlagen der Quantentheorie, Akad. Verlagsges., 1979 6.Kittel, Introduction to Solid State Physics, 8th ed., Wiley, 2004 7.Ashcroft, Mermin, Solid State Physics, Harcourt, 1976 8.Pierret, Semiconductor Fundamentals Vol. 1, Addison Wesley, 1988 9.Sze, Physics of Semiconductor Devices, Wiley, 1981 10.Saleh, Teich, Fundamentals of Photonics, 2nd ed., 2007 11.Joannopoulos, Johnson, Winn Meade, Photonic Crystals, 2nd ed., Princeton Universty Press, 2008 12.Handley, Modern Magnetic Materials, Wiley, 2000 13.Wikipedia, Wikimedia

Course L0687: Materials in Electrical Engineering (Problem Solving Course)	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Manfred Eich
Language	DE
Cycle	SoSe
Content	• Atom structure and periodic system • Atom binding and crystal structure • Structure and properties of alloys: diffusion, phase diagrams, phase separation and grain boundaries • Material properties: Mechanical, thermal, electrical, dielectric properties • Metals • Semiconductors • Ceramics and glasses • Polymers • Magnetic materials • Electrochemistry Oxidation numbers, electrolysis, batteries, fuel cells
Literature	H. Schaumburg: Einführung in die Werkstoffe der Elektrotechnik, Teubner (1993)

Module M0668: Algebra and Control

Courses

Title	Typ	Hrs/wk	CP
Algebra and Control (L0428)	Lecture	2	4
Algebra and Control (L0429)	Recitation Section (small)	2	2

Module Responsible	Dr. Prashant Batra
Admission Requirements	None
Recommended Previous Knowledge	Basics of Real Analysis and Linear Algebra of Vector Spaces and either of: Introduction to Control Theory or: Discrete Mathematics
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can • Describe input-output systems polynomially • Explain factorization approaches to transfer functions • Name stabilization conditions for systems in coprime stable factorization.
Skills	Students are able to • Undertake a synthesis of stable control loops • Apply suitable methods of analysis and synthesis to describe all stable control loops • Ensure the fulfillment of specified performance measurements.
Personal Competence	
Social Competence	
Autonomy	
Workload in Hours	Independent Study Time 124, Study Time in Lecture 56
Credit points	6
Examination	Oral exam
Examination duration and scale	30 min
Assignment for the Following Curricula	Computer Science: Specialisation Computational Mathematics: Elective Compulsory Electrical Engineering: Core qualification: Elective Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory Technomathematics: Specialisation II. Informatics: Elective Compulsory Technomathematics: Core qualification: Elective Compulsory

Course L0428: Algebra and Control	
Typ	Lecture
Hrs/wk	2
CP	4
Workload in Hours	Independent Study Time 92, Study Time in Lecture 28
Lecturer	Dr. Prashant Batra
Language	DE/EN
Cycle	SoSe
Content	- Algebraic control methods, polynomial and fractional approach -Single input - single output (SISO) control systems synthesis by algebraic methods, - Simultaneous stabilization - Parametrization of all stabilizing controllers - Selected methods of pole assignment. - Filtering and sensitivity minimization - Polynomial matrices, left and right polynomial fractions. - Euclidean algorithm, diophantine equations over rings - Smith-McMillan normal form - Multiple input - multiple output control system synthesis by polynomial methods, condition of stability.
Literature	• Vidyasagar, M.: Control system synthesis: a factorization approach. The MIT Press,Cambridge/Mass. - London, 1985. • Vardulakis, A.I.G.: Linear multivariable control. Algebraic analysis and synthesis methods, John Wiley & Sons,Chichester,UK,1991. • Chen, Chi-Tsong: Analog and digital control system design. Transfer-function, state-space, and algebraic methods. Oxford Univ. Press,1995. • Kučera, V.: Analysis and Design of Discrete Linear Control Systems. Praha: Academia, 1991.

Course L0429: Algebra and Control	
Typ	Recitation Section (small)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dr. Prashant Batra
Language	DE/EN
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Module M0634: Introduction into Medical Technology and Systems

Courses

Title	Typ	Hrs/wk	CP
Introduction into Medical Technology and Systems (L0342)	Lecture	2	3
Introduction into Medical Technology and Systems (L0343)	Project Seminar	2	2
Introduction into Medical Technology and Systems (L1876)	Recitation Section (large)	1	1

Module Responsible	Prof. Alexander Schlaefer
Admission Requirements	none
Recommended Previous Knowledge	principles of math (algebra, analysis/calculus) principles of stochastics principles of programming, R/Matlab
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	The students can explain principles of medical technology, including imaging systems, computer aided surgery, and medical information systems. They are able to give an overview of regulatory affairs and standards in medical technology.
Skills	The students are able to evaluate systems and medical devices in the context of clinical applications.
Personal Competence	
Social Competence	The students describe a problem in medical technology as a project, and define tasks that are solved in a joint effort.
Autonomy	The students can reflect their knowledge and document the results of their work. They can present the results in an appropriate manner.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Examination	Written exam
Examination duration and scale	90 minutes
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Biomedical Engineering: Compulsory Computer Science: Specialisation Computer and Software Engineering: Elective Compulsory Electrical Engineering: Core qualification: Elective Compulsory General Engineering Science (English program): Specialisation Biomedical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Biomedical Engineering: Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory Computational Science and Engineering: Specialisation Computer Science: Elective Compulsory Biomedical Engineering: Specialisation Artificial Organs and Regenerative Medicine: Elective Compulsory Biomedical Engineering: Specialisation Implants and Endoprostheses: Elective Compulsory Biomedical Engineering: Specialisation Medical Technology and Control Theory: Elective Compulsory Biomedical Engineering: Specialisation Management and Business Administration: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory

Course L0342: Introduction into Medical Technology and Systems

Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	DE
Cycle	SoSe
Content	- imaging systems - computer aided surgery - medical sensor systems - medical information systems - regulatory affairs - standard in medical technology The students will work in groups to apply the methods introduced during the lecture using problem based learning.
Literature	Wird in der Veranstaltung bekannt gegeben.

Course L0343: Introduction into Medical Technology and Systems

Typ	Project Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Prof. Alexander Schlaefer
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Course L1876: Introduction into Medical Technology and Systems	
Typ	Recitation Section (large)
Hrs/wk	1
CP	1
Workload in Hours	Independent Study Time 16, Study Time in Lecture 14
Lecturer	Prof. Alexander Schlaefer
Language	DE
Cycle	SoSe
Content	
Literature	

Module M0610: Electrical Machines

Courses			
Title	**Typ**	**Hrs/wk**	**CP**
Electrical Machines (L0293)	Lecture	3	4
Electrical Machines (L0294)	Recitation Section (large)	2	2

Module Responsible	NN
Admission Requirements	none
Recommended Previous Knowledge	Basics of mathematics, in particular complexe numbers, integrals, differentials Basics of electrical engineering and mechanical engineering
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can to draw and explain the basic principles of electric and magnetic fields. They can describe the function of the standard types of electric machines and present the corresponding equations and characteristic curves. For typically used drives they can explain the major parameters of the energy efficiency of the whole system from the power grid to the driven engine.
Skills	Students arw able to calculate two-dimensional electric and magnetic fields in particular ferromagnetic circuits with air gap. For this they apply the usual methods of the design auf electric machines. They can calulate the operational performance of electric machines from their given characteristic data and selected quantities and characteristic curves. They apply the usual equivalent circuits and graphical methods.
Personal Competence	
Social Competence	none
Autonomy	Students are able independently to calculate electric and magnatic fields for applications. They are able to analyse independently the operational performance of electric machines from the charactersitic data and theycan calculate thereof selected quantities and characteristic curves.
Workload in Hours	Independent Study Time 110, Study Time in Lecture 70
Credit points	6
Examination	Written exam
Examination duration and scale	120 Minuten
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (German program): Specialisation Mechanical Engineering: Elective Compulsory General Engineering Science (German program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory Electrical Engineering: Core qualification: Elective Compulsory Energy and Environmental Engineering: Core qualification: Compulsory General Engineering Science (English program): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (English program): Specialisation Mechanical Engineering: Elective Compulsory General Engineering Science (English program, 7 semester): Specialisation Energy and Enviromental Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Mechanical Engineering: Elective Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory Logistics and Mobility: Specialisation Engineering Science: Elective Compulsory Mechanical Engineering: Core qualification: Elective Compulsory Mechatronics: Core qualification: Compulsory

Course L0293: Electrical Machines	
Typ	Lecture
Hrs/wk	3
CP	4
Workload in Hours	Independent Study Time 78, Study Time in Lecture 42
Lecturer	NN
Language	DE
Cycle	SoSe
Content	Electric field: Coulomb´s law, flux (field) line, work, potential, capacitor, energy, force Magnetic field: force, flux line, Ampere´s law, field at bounderies, flux, magnetic circuit, hysteresis, induction, self-induction, mutual inductance, transformer DC-Machines: Construction and layout, torque generation mechanismen, torque vs speed characteristics, commutation, Asynchronous Machines. Magnetic field, construction and layout, equivalent single line diagram, complex stator current diagram (Heylands´diagram), torque vs. speed characteristics, rotor layout (Squirrelcage vs. sliprings), Synchronous machines, construction and layout, equivalent single line diagrams, no-load and short-cuircuit characteristics, vector diagrams, motor and generator operation drives with variable speed, inverter fed operation, special drives, step motors,
Literature	Hermann Linse, Roland Fischer: "Elektrotechnik für Maschinenbauer", Vieweg-Verlag; Signatur der Bibliothek der TUHH: ETB 313 Ralf Kories, Heinz Schmitt-Walter: "Taschenbuch der Elektrotechnik"; Verlag Harri Deutsch; Signatur der Bibliothek der TUHH: ETB 122 "Grundlagen der Elektrotechnik" - anderer Autoren Fachbücher "Elektrische Maschinen"

Course L0294: Electrical Machines	
Typ	Recitation Section (large)
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	NN
Language	DE
Cycle	SoSe
Content	Exercises to the application of electric and magnetic fields. Excercises to the operational performance of eletric machines.
Literature	Hermann Linse, Roland Fischer: "Elektrotechnik für Maschinenbauer", Vieweg-Verlag; Signatur der Bibliothek der TUHH: ETB 313 Ralf Kories, Heinz Schmitt-Walter: "Taschenbuch der Elektrotechnik"; Verlag Harri Deutsch; Signatur der Bibliothek der TUHH: ETB 122 "Grundlagen der Elektrotechnik" - anderer Autoren Fachbücher "Elektrische Maschinen"

Module M0709: Electrical Engineering IV: Transmission Lines and Research Seminar

Courses

Title	Typ	Hrs/wk	CP
Research Seminar Electrical Engineering, Computer Science, Mathematics (L0571)	Seminar	2	2
Transmission Line Theory (L0570)	Lecture	2	3
Transmission Line Theory (L0572)	Recitation Section (large)	2	1

Module Responsible	Prof. Arne Jacob
Admission Requirements	none
Recommended Previous Knowledge	Electrical Engineering I-III, Mathematics I-III
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	Students can explain the fundamentals of wave propagation on transmission lines at low and high frequencies. They are able to analyze circuits with transmission lines in time and frequency domain. They can describe simple equivalent circuits of transmission lines. They are able to solve problems with coupled transmission lines. They can present and discuss a self-chosen research topic.
Skills	Students can analyze and calculate the propagation of waves in simple circuits with transmission lines. They are able to analyze circuits in frequency domain and with the Smith chart. They can analyze equivalent circuits of transmission lines. They are able to solve problems including coupled transmission lines using the vectorial transmission line equations. They are able to give a talk to professionals.
Personal Competence	
Social Competence	Students can analyze and solve problems in small groups and discuss their solutions. They can compare the learned theory with experiments in the lecture and discuss it in small groups. They are able to present a research topic to professionals and discuss it with them.
Autonomy	The students can solve problems by their own and are able to acquire skills from the lecture and the literature. They are able to test their knowledge using computer animations. They can test their level of knowledge by answering short questions and tests during the lecture. They are able to relate their acquired knowledge to other lectures (e.g. Electrical Engineering I-III and Mathematics I-III). They can familiarize themselves with a research topic and can prepare a presentation.
Workload in Hours	Independent Study Time 96, Study Time in Lecture 84
Credit points	6
Examination	Written exam
Examination duration and scale	150 min
Assignment for the Following Curricula	General Engineering Science (German program): Specialisation Electrical Engineering: Compulsory General Engineering Science (German program, 7 semester): Specialisation Electrical Engineering: Compulsory Electrical Engineering: Core qualification: Compulsory General Engineering Science (English program): Specialisation Electrical Engineering: Compulsory General Engineering Science (English program, 7 semester): Specialisation Electrical Engineering: Compulsory Computational Science and Engineering: Specialisation Engineering Sciences: Elective Compulsory Technomathematics: Specialisation III. Engineering Science: Elective Compulsory Technomathematics: Core qualification: Elective Compulsory

Course L0571: Research Seminar Electrical Engineering, Computer Science, Mathematics

Typ	Seminar
Hrs/wk	2
CP	2
Workload in Hours	Independent Study Time 32, Study Time in Lecture 28
Lecturer	Dozenten des SD E
Language	DE/EN
Cycle	SoSe
Content	Seminar talk on a given subject
Literature	Themenabhängig / subject related

Course L0570: Transmission Line Theory	
Typ	Lecture
Hrs/wk	2
CP	3
Workload in Hours	Independent Study Time 62, Study Time in Lecture 28
Lecturer	Prof. Arne Jacob
Language	DE
Cycle	SoSe
Content	- Wave propagation along transmission lines - Transient behavior of transmission lines - Transmission lines in steady state - Impedance transformation and Smith chart - Equivalent circuits - Coupled transmission lines and symmetrical components
Literature	- Unger, H.-G., "Elektromagnetische Wellen auf Leitungen", Hüthig Verlag (1991)

Course L0572: Transmission Line Theory	
Typ	Recitation Section (large)
Hrs/wk	2
CP	1
Workload in Hours	Independent Study Time 2, Study Time in Lecture 28
Lecturer	Prof. Arne Jacob
Language	DE
Cycle	SoSe
Content	See interlocking course
Literature	See interlocking course

Thesis

Module M-001: Bachelor Thesis

Courses			
Title	Typ	Hrs/wk	CP

Module Responsible	Professoren der TUHH
Admission Requirements	• According to General Regulations §24 (1): At least 126 ECTS credit points have to be achieved in study programme. The examinations board decides on exceptions.
Recommended Previous Knowledge	
Educational Objectives	After taking part successfully, students have reached the following learning results
Professional Competence	
Knowledge	• The students can select, outline and, if need be, critically discuss the most important scientific fundamentals of their course of study (facts, theories, and methods). • On the basis of their fundamental knowledge of their subject the students are capable in relation to a specific issue of opening up and establishing links with extended specialized expertise. • The students are able to outline the state of research on a selected issue in their subject area.
Skills	• The students can make targeted use of the basic knowledge of their subject that they have acquired in their studies to solve subject-related problems. • With the aid of the methods they have learnt during their studies the students can analyze problems, make decisions on technical issues, and develop solutions. • The students can take up a critical position on the findings of their own research work from a specialized perspective.
Personal Competence	
Social Competence	• Both in writing and orally the students can outline a scientific issue for an expert audience accurately, understandably and in a structured way. • The students can deal with issues in an expert discussion and answer them in a manner that is appropriate to the addressees. In doing so they can uphold their own assessments and viewpoints convincingly.
Autonomy	• The students are capable of structuring an extensive work process in terms of time and of dealing with an issue within a specified time frame. • The students are able to identify, open up, and connect knowledge and material necessary for working on a scientific problem. • The students can apply the essential techniques of scientific work to research of their own.
Workload in Hours	Independent Study Time 360, Study Time in Lecture 0
Credit points	12
Examination	according to Subject Specific Regulations
Examination duration and scale	laut FSPO
Assignment for the Following Curricula	General Engineering Science (German program): Thesis: Compulsory General Engineering Science (German program, 7 semester): Thesis: Compulsory Civil- and Environmental Engineering: Thesis: Compulsory Bioprocess Engineering: Thesis: Compulsory Computer Science: Thesis: Compulsory Electrical Engineering: Thesis: Compulsory Energy and Environmental Engineering: Thesis: Compulsory General Engineering Science (English program): Thesis: Compulsory General Engineering Science (English program, 7 semester): Thesis: Compulsory Computational Science and Engineering: Thesis: Compulsory Logistics and Mobility: Thesis: Compulsory Mechanical Engineering: Thesis: Compulsory Mechatronics: Thesis: Compulsory Naval Architecture: Thesis: Compulsory Technomathematics: Thesis: Compulsory xx: Thesis: Compulsory Process Engineering: Thesis: Compulsory