UNIVERSITÄT ZU LÜBECK

Module Guide for the Study Path

Bachelor Robotics and Autonomous Systems 2016

Version from 1. October 2025

1st semester

2nd and 3rd semester

2nd semester

3rd semester

4th or 6th semester

4th semester

5th or 6th semester

5th semester

6th semester

CS1000-KP10, CS1000SJ14 - Introduction to Programming (EinfProg14)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	10

Course of study, specific field and term:

- Bachelor Media Informatics 2020 (compulsory: aptitude test), computer science, 1st semester
- Bachelor Computer Science 2019 (compulsory: aptitude test), foundations of computer science, 1st semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory), foundations of computer science, 1st semester
- Bachelor Computer Science 2016 (compulsory: aptitude test), foundations of computer science, 1st semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), computer science, 1st semester
- Bachelor IT-Security 2016 (compulsory: aptitude test), computer science, 1st semester
- Bachelor Media Informatics 2014 (compulsory: aptitude test), computer science, 1st semester
- Bachelor Computer Science 2014 (compulsory: aptitude test), foundations of computer science, 1st semester

Classes and lectures:

- Introduction to Programming (lecture, 2 SWS)
- Lab course Java (lecture, 2 SWS)
- Lab course Java (exercise, 2 SWS)
- Java project (programming project, 2 SWS)

Workload:

- 150 Hours private studies
- 90 Hours in-classroom work
- 30 Hours work on project
- 30 Hours exam preparation

Contents of teaching:

- Basic concepts of computer science: representation of information and numbers, hardware, software, operating systems, applications
- Algorithm, Specification, Program
- Syntax und Semantics of Programming Languages
- Basic concepts of imperative and OO programming
- Techniques of secure programming
- Programming in Java including term-long project
- Development environment for Java

Qualification-goals/Competencies:

- Students can easily calculate in 2, 8 and 16 number systems and convert numbers into each other in these systems.
- Students can convert rational and real numbers into floating point numbers and vice versa.
- Students can explain the principles of text encoding in ASCII, Unicode, and UTF-8.
- Students can independently represent the term 'algorithm' and important properties.
- Students can explain the structure and semantics of imperative programs.
- Students master the technique of reading and understanding imperative algorithms and writing them down for simple problems.
- Students can apply basic algorithmic techniques such as iteration and recursion.
- Students are basically able to apply safe programming techniques.
- Students can design, implement and test simple simple programs
- Students can develop and implement solutions satisfying commonly accepted quality standards
- Students can implement limited, but no longer small software development projects in a team.

Grading through:

- written exam
- successful addressing of the project goals

Is requisite for:

- Lab Course Software Engineering (CS2301-KP06, CS2301)
- Software Engineering (CS2300-KP06, CS2300SJ14)
- Algorithms and Data Structures (CS1001-KP08, CS1001)

Responsible for this module:

- Prof. Dr. Stefan Fischer

Teacher:

- Institute of Telematics
- Prof. Dr. Stefan Fischer

Literature:

- H. P. Gumm and M. Sommer: Einführung in die Informatik - Oldenbourg, 10. Auflage, 2012
- G. Goos und W. Zimmermann: Vorlesungen über Informatik (Band 1 und 2) - Springer-Verlag, 2006
- D. J. Barnes und M. Kölling: Java lernen mit BlueJ - Objects first - eine Einführung in Java - 6. Auflage, Pearson Studium, 2017
- T. Stark und G. Krüger: Handbuch der Java-Programmierung - 5. Auflage, Addison-Wesley, 2007
- R. Sedgewick und K. Wayne: Einführung in die Programmierung mit Java - Pearson Studium

Language:

- offered only in German

Notes:

From WS2019 / 20:
Partial Examination CS1000-L1: Introduction to Programming and Programming Course (graded exam, 8 credits)
Partial exam CS1000-L2: Java project (ungraded internship, 2 credits)

Prerequisites for attending the module:
- None

Prerequisites for the exam in CS1000-L1:
- Successful completion of homework assignments during the semester.

Prerequisites for the exam in CS1000-L2:
- None

CS1500-KP04, CS1500 - Introduction to Robotics and Automation (ERA)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Bachelor IT-Security 2016 (optional subject), interdisciplinary, Arbitrary semester
- Bachelor Biophysics 2024 (compulsory), Elective Computer Science, 5th semester
- Bachelor Computer Science 2019 (optional subject), Introductory Module Computer Science, 1st semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory), Robotics and Autonomous Systems, 1st semester
- Bachelor Medical Informatics 2019 (optional subject), medical computer science, 4th to 6th semester
- Bachelor Computer Science 2016 (optional subject), Introductory Module Computer Science, 1st semester
- Bachelor Biophysics 2016 (compulsory), Elective Computer Science, 5th semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 1st semester
- Bachelor Medical Informatics 2014 (optional subject), medical computer science, 5th or 6th semester
- Bachelor Computer Science 2014 (compulsory), specialization field robotics and automation, 1st semester
- Bachelor CLS 2010 (optional subject), computer science, 5th or 6th semester
- Bachelor MES 2011 (optional subject), medical engineering science, 5th semester
- Bachelor Computer Science 2012 (compulsory), specialization field robotics and automation, 1st semester

Classes and lectures:

- Introduction to Robotics and Automation (lecture, 2 SWS)
- Introduction to Robotics and Automation (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Introduction
- Control systems
- Programmable Logic Controller (PLC)
- Combinatorial control
- Sequential control
- Feedback control systems
- Plants
- PID controller
- Controller parameterization
- Autonomous mobile robots
- AI-paradigms
- Elementary and emergent behaviors
- Signal acquisition and processing
- Actuators
- According to the rules of GSP of the UzL

Qualification-goals/Competencies:

- The students are able to explain the principles of control systems.
- The students are able to design combinatorial and sequential control systems.
- The students are able to program simple application problems as PLC-program in the IEC-languages.
- The students are able to analyze closed-loop controlled systems (plants) and to select and parameterize a suitable feedback PID controller.
- The students are able to present the principal structure and functionality of autonomous wheel-driven robots.
- The students are able to program simple autonomous robots in a behavior-based way..

Grading through:

- written exam

Responsible for this module:

- Prof. Dr.-Ing. Mladen Berekovic

Teacher:

- Institute of Computer Engineering

- Dr.-Ing. Kristian Ehlers

Literature:

- J. L. Jones, D. Roth: Robot Programming - A Practical Guide to Behavior-Based Robotics - New York: Mc Graw Hill 2004
- J. Knespl: Automatisierungstechnik 1 - Regelungstechnik - Köln: Stam-Verlag 1999
- R. R. Murphy: Introduction to AI Robotics - Cambridge, MA: The MIT Press 2000
- G. Wellenreuther, D. Zastrow: Automatisieren mit SPS - Theorie und Praxis - Braunschweig: Vieweg 2008

Language:

- offered only in German

Notes:

-Computer Science students are issued a B certificate, after having finished entire assignments including the tests and having passed the written exam at the end of the term.
Students of other majors are issued an A-certificate after having passed the written exam.

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Successful completion of homework assignments during the semester.

Written exam:
-CS1500-L1: Introduction to Robotics and Automation, written exam, 60 - 120 min, 100% modul grade.

MA1000-KP08, MA1000 - Linear Algebra and Discrete Structures 1 (LADS1)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	8

Course of study, specific field and term:

- Minor in Teaching Mathematics, Bachelor of Arts 2023 (compulsory), mathematics, 3rd semester
- Bachelor CLS 2023 (compulsory), mathematics, 1st semester
- Bachelor Biophysics 2024 (compulsory), mathematics, 1st semester
- Bachelor Biophysics 2024 (compulsory), mathematics, 1st semester
- Bachelor MES 2020 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Media Informatics 2020 (compulsory), mathematics, 3rd semester
- Bachelor Computer Science 2019 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Medical Informatics 2019 (compulsory: aptitude test), mathematics, 1st semester
- Minor in Teaching Mathematics, Bachelor of Arts 2017 (compulsory), mathematics, 3rd semester
- Bachelor Computer Science 2016 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor CLS 2016 (compulsory), mathematics, 1st semester
- Bachelor IT-Security 2016 (compulsory), mathematics, 1st semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Biophysics 2016 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Medical Informatics 2014 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor MES 2014 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Media Informatics 2014 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Computer Science 2014 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Medical Informatics 2011 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Computer Science 2012 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor MES 2011 (compulsory), mathematics, 1st semester
- Bachelor CLS 2010 (compulsory), mathematics, 1st semester

Classes and lectures:

- Linear Algebra and Discrete Structures 1 (lecture, 4 SWS)
- Linear Algebra and Discrete Structures 1 (exercise, 2 SWS)

Workload:

- 125 Hours private studies and exercises
- 90 Hours in-classroom work
- 25 Hours exam preparation

Contents of teaching:

- Fundamentals: logic, sets, mappings
- Relations, equivalence relations, orderings
- Proof by induction
- Groups: fundamentals, finite groups, permutations, matrices
- Rings, fields, congruencies
- Complex numbers: calculus, representation, roots of unity
- Vector spaces: bases, dimension, scalar product, norms

Qualification-goals/Competencies:

- Students understand the fundamental concepts of linear algebra.
- They understand basic thought processes and methods of proof.
- They can explain fundamental relationships in linear algebra.
- They can apply fundamental concepts and methods of proof to algebraic problems.
- They have an understanding of abstract thought processes.
- Interdisciplinary qualifications:
- Students have basic competency in modelling.
- They can transfer fundamental theoretical concepts to similar applications.
- They can work on elementary mathematics problems within a team.
- They can present elementary solutions to their problems to a group.

Grading through:

- written exam

Is requisite for:

- Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500)

Responsible for this module:

- Prof. Dr. rer. nat. Jan Modersitzki

Teacher:

- Institute of Mathematics and Image Computing
- Prof. Dr. rer. nat. Jan Modersitzki
- Prof. Dr. rer. nat. Jan Lellmann

Literature:

- G. Fischer: Lineare Algebra: Eine Einführung für Studienanfänger - Vieweg+Teubner
- G. Strang: Lineare Algebra - Springer
- K. Jänich: Lineare Algebra - Springer
- D. Lau: Algebra und diskrete Mathematik I + II - Springer
- G. Strang: Introduction to Linear Algebra - Cambridge Press
- K. Rosen: Discrete Mathematics and Its Applications - McGraw-Hill

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Successful completion of homework assignments during the semester
- Successful completion of e-tests during the semester
- Presentation of homework assignment

Module exam:
- MA1000-L1: Linear Algebra and Discrete Structures 1, written exam, 90 min, 100 % of module grade

MA2000-KP08, MA2000 - Analysis 1 (Ana1KP08)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	8

Course of study, specific field and term:

- Bachelor CLS 2023 (compulsory), mathematics, 1st semester
- Minor in Teaching Mathematics, Bachelor of Arts 2023 (compulsory), mathematics, 5th semester
- Bachelor Biophysics 2024 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor MES 2020 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Media Informatics 2020 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Computer Science 2019 (compulsory), mathematics, 1st semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Medical Informatics 2019 (compulsory), mathematics, 1st semester
- Minor in Teaching Mathematics, Bachelor of Arts 2017 (compulsory), mathematics, 5th semester
- Bachelor Computer Science 2016 (compulsory), mathematics, 1st semester
- Bachelor CLS 2016 (compulsory), mathematics, 1st semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor IT-Security 2016 (compulsory), mathematics, 1st semester
- Bachelor Biophysics 2016 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Medical Informatics 2014 (compulsory), mathematics, 1st semester
- Bachelor Media Informatics 2014 (compulsory), mathematics, 1st semester
- Bachelor MES 2014 (compulsory: aptitude test), mathematics, 1st semester
- Bachelor Computer Science 2014 (compulsory), mathematics, 1st semester
- Bachelor Medical Informatics 2011 (compulsory), mathematics, 3rd semester
- Bachelor CLS 2010 (compulsory), mathematics, 1st semester
- Bachelor MES 2011 (compulsory), mathematics, 1st semester
- Bachelor Computer Science 2012 (compulsory), mathematics, 3rd semester

Classes and lectures:

- Analysis 1 (lecture, 4 SWS)
- Analysis 1 (exercise, 2 SWS)

Workload:

- 125 Hours private studies
- 90 Hours in-classroom work
- 25 Hours exam preparation

Contents of teaching:

- Sequences and series
- Functions and continuity
- Differentiability, Taylor series
- Metric and normalized spaces, basic topological concepts
- Multivariate differential calculus

Qualification-goals/Competencies:

- Students understand the basic terms of analysis, especially the concept of convergence.
- Students understand the basic thoughts and proof techniques and are able to use them for the analytical treatment of scientifially or technically motivated problems.
- Students can explain basic relationships in real analysis.
- Students can apply the basic concepts and proof techniques of differential calculus.
- Students have an understanding for abstract structures.
- Interdisciplinary qualifications:
- Students have a basic competence in modeling.
- Students can transfer theoretical concepts to similar applications.
- Students can work as a group on elementary mathematical problems.

Grading through:

- written exam

Is requisite for:

- Analysis 2 (MA2500-KP09)
- Analysis 2 (MA2500-KP08)

- Analysis 2 (MA2500-KP05, MA2500-MLS)
- Analysis 2 (MA2500-KP04, MA2500)

Responsible for this module:

- Prof. Dr. rer. nat. Jürgen Prestin

Teacher:

- Institute for Mathematics

- Prof. Dr. rer. nat. Jürgen Prestin
- PD Dr. rer. nat. Jörn Schnieder

Literature:

- K. Fritzsche: Grundkurs Analysis 1 + 2
- H. Heuser: Lehrbuch der Analysis 1 + 2
- K. Burg, H. Haf, F. Wille, A. Meister: Höhere Mathematik für Ingenieure
- R. Lasser, F. Hofmaier: Analysis 1 + 2

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of homework assignments during the semester
- Successful completion of e-tests

Modul exam:
- MA2000-L1: Analysis 1, written exam, 90 min, 100 % of module grade

RO1500-KP08 - Technical Mechanics (TechMec)

Duration:	Turnus of offer:	Credit points:
2 Semester	starts every summer semester	8

Course of study, specific field and term:

- Bachelor Robotics and Autonomous Systems 2020 (compulsory), Robotics and Autonomous Systems, 2nd and 3rd semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 2nd and 3rd semester

Classes and lectures:

- Engineering Mechanics 2 (lecture, 2 SWS)
- Engineering Mechanics 2 (exercise, 2 SWS)
- Engineering Mechanics 1 (lecture, 2 SWS)
- Engineering Mechanics 1 (exercise, 2 SWS)

Workload:

- 120 Hours in-classroom work
- 120 Hours private studies and exercises

Contents of teaching:

- Statics and Elastostatics
- Systems and equilibria of forces and moments
- Gravitational force and center of mass
- Planar systems of forces
- Bearings and support of multibody systems
- Trusses
- Principle of virtual displacements
- Law of elasticity
- Beam theory
- Stability of elastic systems
- Energy conservation and approximate methods
- Torsion
- Kinematics of point masses
- Kinetics of point masses
- Kinematics of rigid bodies
- Kinetics of rigid bodies
- Linearization
- Vibration theory
- Product development and construction process
- Requirements and target specification
- Methods for identifying solutions, selection and evaluation
- Methods of verification and fault prevention

Qualification-goals/Competencies:

- Students can explain the structure and basic properties of static mechanical systems.
- They can calculate static mechanical systems.
- They can develop products methodically and possess the necessary knowledge and skills.
- They are able to model dynamic mechanical systems using kinetics and kinematic relations.

Grading through:

- written examination

Responsible for this module:

- Prof. Dr. Georg Schildbach

Teacher:

- Institute for Electrical Engineering in Medicine
- Prof. Dr.-Ing. Christian Herzog
- Prof. Dr. Georg Schildbach

Literature:

- Dankert, Jürgen; Dankert, Helga: Technische Mechanik. Statik, Festigkeitslehre, Kinematik/Kinetik - 7. Aufl. Wiesbaden: Springer Vieweg

2013
- Gross, Dietmar; Hauger, Werner; Schröder, Jörg; Wall, Wolfgang A.: Technische Mechanik 1. Statik - With assistance of Dietmar Gross. 12., aktualisierte. Aufl. Berlin [u.a.]: Springer Vieweg (Springer-Lehrbuch) 2013
- Gross, Dietmar; Hauger, Werner; Schröder, Jörg; Wall, Wolfgang A.: Technische Mechanik 2. Elastostatik - [Verschiedene Aufl.]. Berlin: Springer Vieweg (Springer-Lehrbuch) 2014
- Gross, Dietmar; Hauger, Werner; Schröder, Jörg; Wall, Wolfgang A.: Technische Mechanik 3. Kinetik - 13., überarb. Aufl. Berlin, Heidelberg: Springer Berlin Heidelberg (Springer-Lehrbuch) 2015
- Pahl, Gerhard; Beitz, Wolfgang; Feldhusen, Jörg; Grote, Karl-H: Konstruktionslehre. Grundlagen erfolgreicher Produktentwicklung Methoden und Anwendung - 6. Aufl. Berlin, Heidelberg: Springer-Verlag Berlin Heidelberg 2005

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion and submission of exercises as specified at the beginning of the semester.

Module Exam(s):
- RO1500-L1: Technical Mechanics, written exam, 90min, 100% of the module grade

CS1001-KP08, CS1001 - Algorithms and Data Structures (AuD)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	8

Course of study, specific field and term:

- Bachelor CLS 2023 (compulsory), foundations of computer science, 2nd semester
- Bachelor MES 2020 (optional subject), computer science / electrical engineering, 3rd semester at the earliest
- Bachelor Media Informatics 2020 (compulsory), computer science, 2nd semester
- Bachelor Computer Science 2019 (compulsory: aptitude test), foundations of computer science, 2nd semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory), computer science, 2nd semester
- Bachelor Medical Informatics 2019 (compulsory), computer science, 2nd semester
- Bachelor Computer Science 2016 (compulsory: aptitude test), foundations of computer science, 2nd semester
- Bachelor CLS 2016 (compulsory), foundations of computer science, 2nd semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), computer science, 2nd semester
- Bachelor IT-Security 2016 (compulsory: aptitude test), computer science, 2nd semester
- Bachelor Medical Informatics 2014 (compulsory), computer science, 2nd semester
- Bachelor MES 2014 (optional subject), computer science / electrical engineering, 4th or 6th semester
- Bachelor Media Informatics 2014 (compulsory), foundations of computer science, 2nd semester
- Bachelor Computer Science 2014 (compulsory: aptitude test), foundations of computer science, 2nd semester
- Bachelor Medical Informatics 2011 (compulsory), computer science, 2nd semester
- Bachelor MES 2011 (compulsory), foundations of computer science, 4th semester
- Bachelor CLS 2010 (compulsory), foundations of computer science, 2nd semester
- Bachelor Computer Science 2012 (compulsory: aptitude test), foundations of computer science, 2nd semester

Classes and lectures:

- Algorithms and Data Structures (lecture, 4 SWS)
- Algorithms and Data Structures (exercise, 2 SWS)

Workload:

- 125 Hours private studies
- 90 Hours in-classroom work
- 25 Hours exam preparation

Contents of teaching:

- Sorting, algorithm analysis, heaps
- Distribution sort
- Priority queues
- Sets
- Sets
- Sets of strings
- Disjoint sets
- Associating objects
- Graphs
- Search graph for game playing
- Dynamic Programming principle, greedy algorithms
- Optimization problems, sequence alignment (longest common subsequence), knapsack problem, planning and layout problems, determining change coins, notion of completeness of algorithms
- String matching
- Hard problems
- Pruning and subgraph isomorphism
- Approximation

Qualification-goals/Competencies:

- The students can explain the central ideas, define the relevant concepts and explain the functioning of algorithms with help of application scenarios for all the items listed in contents of teaching.

Grading through:

- written exam

Is requisite for:

- Databases (CS2700-KP04, CS2700)
- Lab Course Software Engineering (CS2301-KP06, CS2301)

- Software Engineering (CS2300-KP06, CS2300SJ14)
- Theoretical Computer Science (CS2000-KP08, CS2000)
- Algorithm Design (CS3000-KP04, CS3000)

Requires:

- Introduction to Programming (CS1000-KP08, CS1000SJ14-MML/MI, CS1000SJ14-MIW)
- Introduction to Programming (CS1000-KP10, CS1000SJ14)

Responsible for this module:

- Prof. Dr. rer. nat. Esfandiar Mohammadi

Teacher:

- Institute for IT Security
- Prof. Dr. rer. nat. Esfandiar Mohammadi

Literature:

- Thomas H. Cormen, Charles E. Leiserson, Ronald Rivest, Clifford Stein: Algorithmen - Eine Einführung - Oldenbourg Verlag, 2013

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None (The competencies of the modules listed under 'Requires' are needed for this module, but are not a formal prerequisite.)

Admission requirements for participation in module examination(s):
- Successful completion of exercise sheets as specified at the beginning of the semester.

Module exam(s):
- CS1001-L1: Algorithms and Data Structures, written exam, 90min, 100% of the module grade.

CS1200-KP06, CS1200SJ14 - Fundamentals of Computer Engineering 1 (TGI1)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	6

Course of study, specific field and term:

- Bachelor MES 2020 (compulsory), computer science, 4th semester
- Bachelor Media Informatics 2020 (compulsory), computer science, 2nd semester
- Bachelor Computer Science 2019 (compulsory), foundations of computer science, 2nd semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory: aptitude test), computer science, 2nd semester
- Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester
- Bachelor Computer Science 2016 (compulsory), foundations of computer science, 2nd semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory: aptitude test), computer science, 2nd semester
- Bachelor IT-Security 2016 (compulsory), computer science, 2nd semester
- Bachelor Biophysics 2016 (optional subject), computer science, 6th semester
- Bachelor Medical Informatics 2014 (compulsory), computer science, 2nd semester
- Bachelor Media Informatics 2014 (compulsory), computer science, 2nd semester
- Bachelor MES 2014 (compulsory), foundations of computer science, 4th semester
- Bachelor Computer Science 2014 (compulsory), foundations of computer science, 2nd semester
- Bachelor Biophysics 2024 (optional subject), computer science, 6th semester

Classes and lectures:

- Fundamentals of Computer Engineering 1 (lecture, 2 SWS)
- Fundamentals of Computer Engineering 1 (exercise, 2 SWS)

Workload:

- 100 Hours private studies
- 60 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Von-Neumann computer
- Switching algebra and switching functions
- Technological realization
- Combinatorial and sequential circuits
- Memories
- Microprocessors
- Assembler programming
- Microcontrollers
- Input/Output programming
- Basic processor architectures

Qualification-goals/Competencies:

- The students can explain the principal organization of a computer and the execution of a program according to the Von-Neumann principle.
- They can elucidate the principal functioning of combinatorial and sequential circuits and describe them formally using switching algebra.
- They can demonstrate the basic circuits for the technological realization of logic gates with bipolar and MOS transistors.
- They can explain the structure and operation of registers and memories.
- They can elucidate the instruction set of a microprocessor exemplarily and to be able to use it for assembly programming.
- Sie können die Ein/Ausgabe-Schnittstellen eines Mikrocontrollers beschreiben und in Assemblersprache programmieren (mit Polling bzw. Interrupt).
- They can program microcontrollers for simple applications in assembly language.
- They can discuss and compare basic processor architectures and their instruction sets.

Grading through:

- written exam

Is requisite for:

- Embedded Systems (CS2101-KP04, CS2101)
- Computer Architecture (CS2100-KP04, CS2100SJ14)
- Fundamentals of Computer Engineering 2 (CS1202-KP06, CS1202)

Responsible for this module:

- Prof. Dr.-Ing. Mladen Berekovic

Teacher:

- Institute of Computer Engineering
- Dr.-Ing. Kristian Ehlers

Literature:

- C. Hamacher, Z. Vranesic, S. Zaky, N. Manjikian: Computer Organisation and Embedded Systems - McGraw-Hill 2012
- M. M. Mano, C. R. Kime: Logic and Computer Design Fundamentals - Pearson 2007
- D. A. Patterson, J. L. Hennessy: Computer Organisation & Design - The Hardware/Software Interface - Morgan Kaufmann 2011
- T. Ungerer, U. Brinkschulte: Mikrocontroller und Mikroprozessoren - Springer 2010

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of practical exercises as specified at the beginning of the semester.

Module examination(s):
- CS1200-L1: Technical Foundations of Computer Science 1, written exam 120min, 100% of module grade.

MA1500-KP08, MA1500 - Linear Algebra and Discrete Structures 2 (LADS2)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	8

Course of study, specific field and term:

- Minor in Teaching Mathematics, Bachelor of Arts 2023 (compulsory), mathematics, 4th semester
- Bachelor CLS 2023 (compulsory), mathematics, 2nd semester
- Bachelor Biophysics 2024 (compulsory), mathematics, 2nd semester
- Bachelor MES 2020 (compulsory), mathematics, 2nd semester
- Bachelor Computer Science 2019 (compulsory: aptitude test), mathematics, 2nd semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory), mathematics, 2nd semester
- Bachelor Medical Informatics 2019 (compulsory), mathematics, 2nd semester
- Minor in Teaching Mathematics, Bachelor of Arts 2017 (compulsory), mathematics, 4th semester
- Bachelor Computer Science 2016 (compulsory: aptitude test), mathematics, 2nd semester
- Bachelor CLS 2016 (compulsory), mathematics, 2nd semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), mathematics, 2nd semester
- Bachelor IT-Security 2016 (compulsory), mathematics, 2nd semester
- Bachelor Biophysics 2016 (compulsory), mathematics, 2nd semester
- Bachelor Medical Informatics 2014 (compulsory), mathematics, 2nd semester
- Bachelor MES 2014 (compulsory), mathematics, 2nd semester
- Bachelor Computer Science 2014 (compulsory: aptitude test), mathematics, 2nd semester
- Bachelor Medical Informatics 2011 (compulsory), mathematics, 2nd semester
- Bachelor CLS 2010 (compulsory), mathematics, 2nd semester
- Bachelor MES 2011 (compulsory), mathematics, 2nd semester
- Bachelor Computer Science 2012 (compulsory: aptitude test), mathematics, 2nd semester

Classes and lectures:

- Linear Algebra and Discrete Structures 2 (lecture, 4 SWS)
- Linear Algebra and Discrete Structures 2 (exercise, 2 SWS)

Workload:

- 125 Hours private studies and exercises
- 90 Hours in-classroom work
- 25 Hours exam preparation

Contents of teaching:

- Systems of linear equations, matrices
- Determinants
- Linear mappings
- Orthogonality
- Eigenvalues

Qualification-goals/Competencies:

- The students understand advanced concepts of linear algebra.
- They understand advanced thought processes and methods of proof.
- They can apply advanced concepts and methods of proof to algebraic problems.
- They can explain advanced relationships in linear algebra.
- Interdisciplinary qualifications:
- Students can transfer advanced theoretical concepts to similar applications.
- They have an advanced competency in modeling.
- They can solve complex problems within a group.
- They can present the solution to complex problems to a group.

Grading through:

- written exam

Is requisite for:

- Image Registration (MA5030-KP05)
- Image Registration (MA5030-KP04, MA5030)
- Mathematical Methods of Image Processing (MA4500-KP05)
- Mathematical Methods in Image Processing (MA4500-KP04, MA4500)
- Optimization (Advanced Mathematics) (MA4031-KP08)

- Module part: Optimization (MA4030 T)
- Optimization (MA4030-KP08, MA4030)

Requires:

- Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000)

Responsible for this module:

- Prof. Dr. rer. nat. Jan Modersitzki

Teacher:

- Institute of Mathematics and Image Computing
- Prof. Dr. rer. nat. Jan Modersitzki
- Prof. Dr. rer. nat. Jan Lellmann

Literature:

- G. Fischer: Lineare Algebra: Eine Einführung für Studienanfänger - Vieweg+Teubner
- G. Strang: Lineare Algebra - Springer
- K. Jänich: Lineare Algebra - Springer
- D. Lau: Algebra und diskrete Mathematik I + II - Springer
- G. Strang: Introduction to Linear Algebra - Cambridge Press
- K. Rosen: Discrete Mathematics and Its Applications - McGraw-Hill

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None (The competencies of the modules listed under 'Requires' are needed for this module, but are not a formal prerequisite)

Prerequisites for the exam:
- Successful completion of homework assignments during the semester
- Successful completion of e-tests during the semester
- Presentation of homework assignment

Module exam:
-MA1500-L1: Linear Algebra and Discrete Structures 2, written exam, 90 min, 100 % of module grade

MA2500-KP04, MA2500 - Analysis 2 (Ana2KP04)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Bachelor Computer Science 2019 (optional subject), Extended optional subjects, Arbitrary semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory), mathematics, 2nd semester
- Bachelor Medical Informatics 2019 (compulsory), mathematics, 2nd semester
- Bachelor IT-Security 2016 (optional subject), mathematics, Arbitrary semester
- Bachelor Computer Science 2016 (compulsory), mathematics, 2nd semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), mathematics, 2nd semester
- Bachelor Medical Informatics 2014 (compulsory), mathematics, 2nd semester
- Bachelor Computer Science 2014 (compulsory), mathematics, 2nd semester
- Bachelor Medical Informatics 2011 (compulsory), mathematics, 4th semester
- Bachelor MES 2011 (compulsory), mathematics, 2nd semester
- Bachelor Computer Science 2012 (compulsory), mathematics, 4th semester

Classes and lectures:

- Analysis 2 (lecture, 2 SWS)
- Analysis 2 (exercise, 1 SWS)

Workload:

- 60 Hours private studies
- 45 Hours in-classroom work
- 15 Hours exam preparation

Contents of teaching:

- Integral calculus for functions of one real variable (indefinite integrals, antiderivatives, substitution, partial fractions, definite integrals, fundamental theorem of calculus)
- Sequences and series of functions
- Fourier series (trigonometric polynomials, convergence)

Qualification-goals/Competencies:

- Students understand the advanced terms of analysis, such as even convergence.
- Students understand the advanced thoughts and proof techniques.
- Students can explain advanced relationships in analysis.
- Interdisciplinary qualifications:
- Students can transfer advanced theoretical concepts to similar applications.
- Students can work as a group on complex mathematical problems.

Grading through:

- written exam

Requires:

- Analysis 1 (MA2000-KP09)
- Analysis 1 (MA2000-KP08, MA2000)

Responsible for this module:

- Prof. Dr. rer. nat. Jürgen Prestin

Teacher:

- Institute for Mathematics
- Prof. Dr. rer. nat. Jürgen Prestin

Literature:

- K. Fritzsche: Grundkurs Analysis 1 + 2
- H. Heuser: Lehrbuch der Analysis 1 + 2
- K. Burg, H. Haf, F. Wille, A. Meister: Höhere Mathematik für Ingenieure
- R. Lasser, F. Hofmaier: Analysis 1 + 2

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None (the competences of the modules mentioned under "requires" are needed for this module, but are not a formal prerequisite).

Admission requirements for the examination:
- Successful completion of exercises during the semester as specified at the beginning of the semester.
- Successful completion of e-tests as specified at the beginning of the semester.

Module Exam(s):
- MA2500-L1: Analysis 2, written exam, 90min, 100% of the module grade

CS1202-KP06, CS1202 - Fundamentals of Computer Engineering 2 (TGI2)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	6

Course of study, specific field and term:

- Bachelor MES 2020 (compulsory), computer science, 5th semester
- Bachelor Media Informatics 2020 (optional subject), computer science, 5th or 6th semester
- Bachelor Computer Science 2019 (compulsory), foundations of computer science, 3rd semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory), computer science, 3rd semester
- Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester
- Bachelor Computer Science 2016 (compulsory), foundations of computer science, 3rd semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), computer science, 3rd semester
- Bachelor Medical Informatics 2014 (optional subject), computer science, 5th or 6th semester
- Bachelor Media Informatics 2014 (optional subject), computer science, 5th or 6th semester
- Bachelor MES 2014 (compulsory), foundations of computer science, 5th semester
- Bachelor Computer Science 2014 (compulsory), foundations of computer science, 3rd semester
- Bachelor IT-Security 2016 (optional subject), specific, Arbitrary semester

Classes and lectures:

- Fundamentals of Computer Engineering 2 (lecture, 2 SWS)
- Fundamentals of Computer Engineering 2 (exercise, 2 SWS)

Workload:

- 100 Hours private studies
- 60 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Design of combinatorial circuits
- Design of sequential circuits
- Hardware description languages
- Register-transfer languages
- Data paths
- Control units
- Microprogramming
- CPUs
- Semiconductor components and circuit families
- Integrated circuits
- Programmable logic (CPLDs, FPGAs)
- CAD-tools for circuit design

Qualification-goals/Competencies:

- The students can formally describe and design combinatorial and sequential circuits on gate level.
- They can use hardware description languages, particularly VHDL, for the modelling of simple circuits.
- They can formally describe and design sequential circuits with control unit and data path on register-transfer level.
- They can exploit microprogramming for the realization of control units.
- They can design simple processors (CPUs).
- They can elucidate and judge the most important technologies for the realization of simple digital circuits (bipolar, MOS, CMOS).
- They can describe and judge integrated circuits, in particular programmable logic like FPGAs.
- They can use CAD-tools to design, to simulate and to implement digital circuits on FPGAs.

Grading through:

- written exam

Is requisite for:

- Computer-Aided Design of Digital Circuits (CS3110-KP04, CS3110)

Requires:

- Fundamentals of Computer Engineering 1 (CS1200-KP06, CS1200SJ14)

Responsible for this module:

- Prof. Dr.-Ing. Mladen Berekovic

Teacher:

- Institute of Computer Engineering

- Dr.-Ing. Kristian Ehlers
- Prof. Dr.-Ing. Mladen Berekovic

Literature:

- T.L. Floyd: Digital Fundamentals - A Systems Approach - Pearson 2012
- M. M. Mano, C. R. Kime: Logic and Computer Design Fundamentals - Pearson 2007
- C. H. Roth, L.L. Kinney: Fundamentals of Logic Design - Cengage Learning 2009

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Successful completion of homework assignments during the semester
- continuous, successful participation in practical course

CS2300-KP06, CS2300SJ14 - Software Engineering (SWEng14)

Duration:	Turnus of offer:	Credit points:	Max. group size:
1 Semester	each winter semester	6	12

Course of study, specific field and term:

- Bachelor Biophysics 2024 (optional subject), computer science, 5th semester
- Bachelor Media Informatics 2020 (compulsory), computer science, 3rd semester
- Bachelor Computer Science 2019 (compulsory), foundations of computer science, 3rd semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory), computer science, 3rd semester
- Bachelor Medical Informatics 2019 (compulsory), computer science, 3rd semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), computer science, 3rd semester
- Bachelor IT-Security 2016 (compulsory), computer science, 3rd semester
- Bachelor Biophysics 2016 (optional subject), computer science, 5th semester
- Bachelor Computer Science 2016 (compulsory), foundations of computer science, 3rd semester
- Bachelor Media Informatics 2014 (compulsory), foundations of computer science, 3rd semester
- Bachelor Medical Informatics 2014 (compulsory), computer science, 3rd semester
- Bachelor Computer Science 2014 (compulsory), foundations of computer science, 3rd semester

Classes and lectures:

- Software Engineering (lecture, 3 SWS)
- Software Engineering (exercise, 1 SWS)

Workload:

- 100 Hours private studies and exercises
- 60 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- overview on major fields of software engineering
- Software development, software process models
- Project plan and workload estimation
- Software management and quality assurance
- System Analysis and requirements analysis
- Basics of UML
- Software architectures and design patterns
- Validation and verification
- Legal aspects: copyright, standards, liability, licenses

Qualification-goals/Competencies:

- The students understand software design as an engineering process.
- They can argue about major software process models.
- They can explain important techniques and factors of software management.
- They can describe and evaluate measures for quality ensurance.
- They are able to model software systemson different levels of abtraction.
- They can apply the basic concepts of object-oriented modelling and design.
- They are able to apply design patterns in a useful way.
- They can discuss about legal aspects of software development.

Grading through:

- Written or oral exam as announced by the examiner

Is requisite for:

- Safe Software (CS3250-KP08)
- Lab Course Software Engineering (CS2301-KP06, CS2301)

Requires:

- Algorithms and Data Structures (CS1001-KP08, CS1001)
- Introduction to Programming (CS1000-KP10, CS1000SJ14)

Responsible for this module:

- Prof. Dr. Martin Leucker

Teacher:

- Institute of Software Technology and Programming Languages

- Prof. Dr. Martin Leucker
- Prof. Dr. Diedrich Wolter

Literature:

- H. Balzert: Lehrbuch der Software-Technik: Software-Entwicklung - Spektrum Akademischer Verlag 2001
- B. Brügge, A. H. Dutoit: Objektorientierte Softwaretechnik mit UML, Entwurfsmustern und Java - Pearson Studium 2004
- I. Sommerville: Software Engineering - Addison-Wesley 2006
- B. Oestereich: Analyse und Design mit der UML 2.1 - Objektorientierte Softwareentwicklung - Oldenbourg 2006
- D. Bjorner: Software Engineering 1-3 - Springer 2006

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None (the competences of the modules mentioned under Requires are needed for this module, but are not a formal prerequisite).

Admission requirements for participation in module examination(s):
- Successful completion of exercises as specified at the beginning of the semester.

Module exam(s):
- CS2300-L1: Software Engineering, written exam, 90min, 100% of the module grade.

Passing this module is a formal requirement for participation in the module CS2301-KP06 Lab Course Software Engineering. It is recommended to do the internship directly in the following semester.

CS2500-KP04, CS2500 - Robotics (Robotik)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Bachelor Robotics and Autonomous Systems 2020 (compulsory), Robotics and Autonomous Systems, 3rd semester
- Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester
- Bachelor MES 2020 (optional subject), computer science / electrical engineering, 3rd semester at the earliest
- Bachelor Media Informatics 2020 (optional subject), Robotics and Autonomous Systems, 5th or 6th semester
- Bachelor Medical Informatics 2019 (optional subject), medical computer science, 4th to 6th semester
- Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 3rd semester
- Bachelor IT-Security 2016 (optional subject), computer science, Arbitrary semester
- Bachelor MES 2014 (optional subject), computer science / electrical engineering, 5th semester
- Bachelor Medical Informatics 2014 (optional subject), medical computer science, 5th or 6th semester
- Bachelor Computer Science 2014 (optional subject), central topics of computer science, 5th semester
- Bachelor Computer Science 2014 (compulsory), specialization field robotics and automation, 3rd semester
- Bachelor Medical Informatics 2011 (optional subject), Applied computer science, 4th to 6th semester
- Bachelor Computer Science 2012 (optional subject), central topics of computer science, 5th semester
- Master CLS 2010 (optional subject), computer science, 3rd semester
- Bachelor MES 2011 (optional subject), medical engineering science, 3rd or 5th semester
- Bachelor Computer Science 2012 (compulsory), specialization field robotics and automation, 3rd semester

Classes and lectures:

- Robotics (lecture, 2 SWS)
- Robotics Exercise (exercise, 2 SWS)

Workload:

- 60 Hours in-classroom work
- 60 Hours private studies

Contents of teaching:

- Description of serial robotic systems: This part includes the basic components like different types of joints, sensors and actors. Exemplarily, the differing kinematic types are introduced. Also, the mathematical backgrounds are presented, necessary for the description of robots. The direct and inverse kinematics for typical 6-jointed industrial robots is explained.
- Parallel robot systems: This part deals with the transfer of the results and mathematical models of part 1 onto robotic systems with parallel kinematics.
- Movement: Robot movements along trajectories/geometric paths are analyzed. Different techniques of path planning are presented as well as methods to determine the configuration space and to perform velocity planning and kinematics.
- Robot Control: Techniques of control theory and examples of programming techniques in robotics are introduced. Sensor and systems calibration as a typical application of robotics is explained in detail.

Qualification-goals/Competencies:

- The students are able to solve application-oriented exercises with mathematical background self-dependent, timely and in team work.
- They have gained basic understanding for the kinematic features of serial and simple parallel robots (includes knowledge of transformations, Euler-/Tail-Bryan-Angles, quaternions, etc.)
- They made first experiences with the programming of simple robotic applications.
- They comprehend the complexity and necessity for different path and dynamic planning techniques.
- The students gained an insight into simple methods for system and sensor calibration.

Grading through:

- portfolio exam

Is requisite for:

- Lab Course Robotics and Automation (CS3501-KP04, CS3501)

Requires:

- Analysis 1 (MA2000-KP08, MA2000)
- Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000)

Responsible for this module:

- Prof. Dr. rer. nat. Floris Ernst

Teacher:

- Institute for Robotics and Cognitive Systems
- Prof. Dr. rer. nat. Floris Ernst

Literature:

- M. Spong et al.: Robot Modeling and Control - Wiley & Sons, 2005
- H.-J. Siegert, S. Bocionek:: Robotik: Programmierung intelligenter Roboter - Springer Verlag, 1996
- J.-P. Merlet: Parallel Robots - Springer Verlag, 2006
- M. Haun: Handbuch Robotik - Springer Verlag, 2007
- S. Niku: Introduction to Robotics: Analysis, Control, Applications - Wiley & Sons, 2010

Language:

- offered only in German

Notes:

Admission requirements for taking the module
- None (the competences of the modules mentioned under Requires are needed for this module, but are not a formal prerequisite)

Admission requirements for participation in module examination(s):
- None

Module Exam(s):
- CS2500-L1: Robotics, portfolio examination consisting, 100% of the module grade

Note: The portfolio examination consists of: 70 points in the form of a written examination at the end of the semester, 15 points in the form of semester-accompanying programming tasks (group and individual performance), 15 points in the form of semester-accompanying intermediate tests (individual performance)

ME2400-KP08, ME2400 - Fundamentals of Electrical Engineering 1 (ETechnik1)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	8

Course of study, specific field and term:

- Bachelor Computer Science 2019 (optional subject), Extended optional subjects, Arbitrary semester
- Bachelor MES 2020 (compulsory), electrical engineering, 3rd semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory), electrical engineering, 3rd semester
- Bachelor MES 2011 (optional subject), electrical engineering, 4th to 6th semester
- Bachelor Computer Science 2016 (optional subject), advanced curriculum, Arbitrary semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 3rd semester
- Bachelor MES 2014 (compulsory), electrical engineering, 3rd semester
- Bachelor IT-Security 2016 (optional subject), specific, Arbitrary semester

Classes and lectures:

- Fundamentals of Electrical Engineering 1 (lecture, 4 SWS)
- Fundamentals of Electrical Engineering 1 (exercise, 2 SWS)

Workload:

- 125 Hours private studies
- 90 Hours in-classroom work
- 25 Hours exam preparation

Contents of teaching:

- Maxwell s Equations and electrical circuits
- Circuit Abstraction
- Passive electrical circuit elements
- Methods of linear and nonlinear circuit analysis
- Measuring voltages and currents
- Equivalent circuit diagram (ideal/nonideal sources, MOSFETs, BJTs)
- MOSFET Switch
- Digital Abstraction
- MOSFET Amplifier

Qualification-goals/Competencies:

- Students understand how electrical circuits are derived from Maxwell s equations and which simplifications are accepted in this process.
- Students can calculate and analyze electrical circuits with passive elements.
- Students understand how complicated circuits, e.g. with MOSFETs and BJTs can be expressed and analyzed by means of equivalent circuit diagrams with sources and passive elements.
- Students know and comprehend the basic physical structure and operation of a MOSFET device as a switch and as an amplifier and know how to describe and analyze its operation.
- Students know the difference between large and small signal analysis and are able to use this to analyze electrical circuits.

Grading through:

- written exam

Is requisite for:

- Fundamentals of Electrical Engineering 2 (ME2700-KP08, ME2700)

Requires:

- Analysis 2 (MA2500-KP04, MA2500)
- Analysis 1 (MA2000-KP08, MA2000)
- Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500)
- Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000)

Responsible for this module:

- Prof. Dr. Philipp Rostalski

Teacher:

- Institute for Electrical Engineering in Medicine

- Prof. Dr. Philipp Rostalski

Literature:

- Argawal, Lang: Foundations of Analog and Digital Circuits - Elsevier; ISBN: 1-55860-735-8
- M. Albach: Elektrotechnik - ISBN: 978-3-8689-4081-7

Language:

- offered only in German

Notes:

In the Bachelor of Computer Science CS3120-KP04 Electronics and Microsystems Engineering and ME2400-KP08 Fundamentals of Electrical Engineering 1
cannot be chosen in combination due to content overlap.

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of exercises as specified at the beginning of the semester.

Module Exam(s):
- ME2400-L1: Fundamentals of Electrical Engineering 1, written exam, 90min, 100% of module grade.

CS1601-KP04, CS1601 - Basics of Multimedia Systems (MMTechnik)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Bachelor Biophysics 2016 (optional subject), computer science, 5th semester
- Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Media Informatics 2020 (compulsory), media informatics, 3rd semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), media informatics, 5th or 6th semester
- Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 4th or 6th semester
- Bachelor IT-Security 2016 (optional subject), computer science, Arbitrary semester
- Bachelor Media Informatics 2014 (compulsory), media informatics, 3rd semester
- Bachelor Computer Science 2014 (optional subject), central topics of computer science, 5th semester
- Bachelor Computer Science 2012 (optional subject), central topics of computer science, 6th semester
- Bachelor CLS 2010 (optional subject), computer science, 6th semester
- Bachelor Computer Science 2012 (compulsory), specialization field media informatics, 2nd semester
- Bachelor Biophysics 2024 (optional subject), computer science, 5th semester

Classes and lectures:

- Basics of Multimedia Systems (lecture, 2 SWS)
- Basics of Multimedia Systems (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Sensation and Perception
- Analog Media Technology
- Digitalisation
- Digital Audio, Image and Video Technology
- Media storage (compression / formats)
- Media Transmission (Broadcast / Streaming)

Qualification-goals/Competencies:

- Students are able to present to essential functions and principles of multimedia systems.
- They are able to judge possibilities and limitations of human perception.
- They are able to classify the conditions and technologies for capturing, processing, storing, transmitting and perception of multimedia.
- They can balance the specific advantages and disadvantages of analog and digital media technology.
- They are able to apply appropriate technical components and processes for the design of multimedia systems.

Grading through:

- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr.-Ing. Andreas Schrader

Teacher:

- Institute of Telematics
- Prof. Dr.-Ing. Andreas Schrader

Literature:

- Thomas Görne: Tontechnik - 4. Auflage, Hanser 2014
- Ulrich Schmidt: Professionelle Videotechnik - 6. Auflage, Springer 2013

Language:

- English, except in case of only German-speaking participants

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of exercise slips as specified at the beginning of the semester.

Module Exam(s):
- CS1601-L1 Fundamentals of Multimedia Technology, as determined by the instructor: Written exam, 90min, 100% of module grade OR oral exam, 100% of module grade.

CS2251-KP04 - Cybersecurity Internship (CyberSecPr)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4 (Typ B)

Course of study, specific field and term:

- Bachelor Robotics and Autonomous Systems 2016 (optional subject), Additionally recognized elective module, 4th or 6th semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), Additionally recognized elective module, 4th or 6th semester
- Bachelor Computer Science 2019 (optional subject), Extended optional subjects, 4th semester
- Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester

Classes and lectures:

- Practical Course Cybersecurity (practical course, 3 SWS)

Workload:

- 50 Hours work on project
- 40 Hours in-classroom work
- 30 Hours group work

Contents of teaching:

- Practical exploitation of security vulnerabilities in various fields of application
- Conduct of risk analyses and implementation of defensive measures
- Analysis of security requirements in a complex use case
- Design, realization, and analysis of a state-of-the-art security solution
- Discussion about attacker motivation, protective measures, and impact of attacks
- Getting acquainted with penetration testing tools

Qualification-goals/Competencies:

- Students can explain the basic methods in the field of cybersecurity and apply them to case studies.
- They can independently perform security analyses for simple scenarios.
- They are able to identify weak points and develop concrete solutions to eliminate them.

Grading through:

- continuous, successful participation in practical course
- project work

Responsible for this module:

- Prof. Dr.-Ing. Thomas Eisenbarth

Teacher:

- Institute for IT Security
- Dr.-Ing. Jan Wichelmann

Literature:

- D. Gollmann: Computer Security, Third Edition, Wiley, 2011 - Third Edition, Wiley, 2011
- R. Anderson: Security Engineering - Second Edition, Wiley, 2008
- C. Kaufman, R. Perlman, and M. Speciner: Network security: private communication in a public world - Second Edition, Prentice Hall, 2002
- W. Du: W. Du: Computer Security: A Hands-on Approach - First Edition, CreateSpace Independent Publishing Platform, 2017

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- None

Module Exam(s):
- CS2251-L1 Practical Cybersecurity, ungraded practical, 100% of (non-existent) module grade.

The course is limited to 60 places; compulsory participants will be given priority; allocation of further places according to registration order in Moodle;

Participation is only possible if CS2250-KP04 Cybersecurity is taken in parallel or has already been taken. Parallel enrollment is recommended.

The courses of this module are also part of CS2250-KP08.

(Share of Institute for IT Security in P is 100%)

CS2100-KP04, CS2100SJ14 - Computer Architecture (RA14)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Bachelor Media Informatics 2020 (optional subject), computer science, 5th or 6th semester
- Bachelor Computer Science 2019 (compulsory), foundations of computer science, 4th semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 5th or 6th semester
- Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester
- Bachelor Computer Science 2016 (compulsory), foundations of computer science, 4th semester
- Bachelor Robotics and Autonomous Systems 2016 (optional suject), computer science, 4th semester
- Bachelor IT-Security 2016 (compulsory), computer science, 4th semester
- Bachelor Medical Informatics 2014 (optional subject), computer science, 5th or 6th semester
- Bachelor Computer Science 2014 (compulsory), foundations of computer science, 4th semester

Classes and lectures:

- Computer Architecture (lecture, 2 SWS)
- Computer Architecture (exercise, 1 SWS)

Workload:

- 60 Hours private studies
- 45 Hours in-classroom work
- 15 Hours exam preparation

Contents of teaching:

- Basic terms and concepts
- Processor architectures
- Computer components
- Parallel computer architectures
- Multiprocessors, multicomputer
- Vector processors, array processors
- Performance evaluation

Qualification-goals/Competencies:

- The students are able to elucidate the microarchitecture of modern processors and the corresponding methods for performance enhancement (caches, pipelining, VLIW, multi/manycore, virtualization etc.).
- They are able to explain important computer components (busses, storage hierachies, I/O-units).
- They are able to discuss and compare the most important parallel computer architectures (multiprocessors, multicomputers, vector computers, array computers etc.).
- They are able to judge and make use of methods for performance evaluation (benchmarks, monitoring, queuing models etc.).

Grading through:

- Written or oral exam as announced by the examiner

Requires:

- Fundamentals of Computer Engineering 1 (CS1200-KP06, CS1200SJ14)

Responsible for this module:

- Prof. Dr.-Ing. Mladen Berekovic

Teacher:

- Institute of Computer Engineering
- Prof. Dr.-Ing. Mladen Berekovic

Literature:

- J.L. Hennessy, D.A. Patterson: Computer Architecture - A Quantitative Approach - Morgan Kaufmann 2011
- D.A. Patterson, J.L. Hennessy: Rechnerorganisation und -entwurf - Die Hardware/Software-Schnittstelle - Pearson Studium 2012
- W. Stallings: Computer Organization and Architecture - Pearson Education 2012
- A.S. Tanenbaum, T. Austin: Structured Computer Organization - Pearson Education 2012

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None (the competencies of the modules listed under

CS2110-KP04, CS2110 - Mobile Robots (MobilRob14)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Bachelor Robotics and Autonomous Systems 2020 (compulsory), Robotics and Autonomous Systems, 4th semester
- Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Media Informatics 2020 (optional subject), Robotics and Autonomous Systems, 5th or 6th semester
- Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 4th semester
- Bachelor Computer Science 2014 (compulsory), specialization field robotics and automation, 5th semester
- Bachelor IT-Security 2016 (optional subject), specific, Arbitrary semester

Classes and lectures:

- Mobile Robots (lecture, 2 SWS)
- Mobile Robots (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Reactive behaviour
- Sensors
- Actuators, kinematics of the drives
- Hybrid deliberative/reactive behaviour
- Strategies of actions
- maps, self-localization
- Routing and navigation
- Robot learning
- Multi-robots
- Human-robot interaction
- Currentds trends, sample robots

Qualification-goals/Competencies:

- The students are able to describe and classify the various AI paradigms for mobile robots (reactive, deliberative, hybrid).
- They are able to explain and evaluate the most important sensors and actuators for mobile robots.
- They are able to describe and apply the basic methods of self-localization, planning and navigation in mobile robotics.
- They are able to iscuss the basic approaches for robot learning as well as multi-robot and human-robot interaction.
- They are able to elucidate the state of the art and current trends in mobile robotics by sample robots.
- They are able to design and program mobile robots.

Grading through:

- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr.-Ing. Mladen Berekovic

Teacher:

- Institute of Computer Engineering
- Dr. rer. nat. Javad Ghofrani

Literature:

- J. Hertzberg, K. Lingemann, A. Nüchter: Mobile Roboter - Springer Vieweg 2012
- R. R. Murphy: Introduction to AI Robotics - Cambridge, MA: The MIT Press 2000
- R. Siegwart, I. R. Nourbakhsh: Introduction to Autonomous Mobile Robots - Cambridge, MA: The MIT Press 2011

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- continuous, successful participation in practical course

CS2150-KP08, CS2150SJ14 - Operating Systems and Networks (BSNetze14)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	8

Course of study, specific field and term:

- Bachelor Media Informatics 2020 (compulsory), computer science, 4th semester
- Bachelor Computer Science 2019 (compulsory), foundations of computer science, 4th semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory), computer science, 4th semester
- Bachelor Medical Informatics 2019 (compulsory), computer science, 4th semester
- Bachelor Computer Science 2016 (compulsory), foundations of computer science, 4th semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), computer science, 4th semester
- Bachelor IT-Security 2016 (compulsory), computer science, 4th semester
- Bachelor Media Informatics 2014 (compulsory), foundations of computer science, 4th semester
- Bachelor Medical Informatics 2014 (compulsory), computer science, 4th semester
- Bachelor Computer Science 2014 (compulsory), foundations of computer science, 4th semester

Classes and lectures:

- Operating Systems and Networks (lecture, 4 SWS)
- Operating Systems and Networks (exercise, 2 SWS)

Workload:

- 130 Hours private studies
- 90 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Tasks and Structure
- Historical Overview of Computer and Operating Systems
- Coding of Symbols and Numbers
- Foundations of Operating Systems
- Processes, Inter-Process Communication and Process Management
- Storage Management
- Input / Output
- Files and File Systems
- Examples (UNIX, Windows, mobile OS)
- Computer Networks and the Internet
- Application Layer
- Transport Layer
- Network Layer
- Link and Physical Layer

Qualification-goals/Competencies:

- Students know about the main concepts of operating systems.
- Students are able to judge, which OS concepts can be appropriately applied to novel computing architectures.
- Students are able to apply the most important strategies and algorithms for operating systems.
- At the end of the course, students know the most important concepts ofcomputer networks
- Students know the importance of the different layers of the OSI andInternet protocol suite along with the most important protocols and services of each layer
- The students are able decide which network technologies to use to meetthe requirements of any given application scenario
- The students know how the Internet works and are able to program smallapplications
- Students can apply the most important methods and algorithms from thefield of networks

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. Stefan Fischer

Teacher:

- Institute of Telematics
- Prof. Dr. Stefan Fischer

- Dr. rer. nat. Florian-Lennert Lau

Literature:

- Andrew S. Tanenbaum: Moderne Betriebssysteme - 3., aktualisierte Auflage, Pearson, April 2009
- James Kurose, Keith Ross: Computer Networking - Der Top-Down-Ansatz - Pearson Studim, 2012
- Andrew S. Tanenbaum: Computernetzwerke - Pearson Studium, 2012

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of exercise assignments as specified at the beginning of the semester.

Module Exam(s):
- CS2150-L1: Operating Systems and Networks, written exam, 90min, 100% of the module grade.

CS2301-KP06, CS2301 - Lab Course Software Engineering (SWEngPrakt)

Duration:	Turnus of offer:	Credit points:	Max. group size:
1 Semester	each summer semester	6 (Typ A)	12

Course of study, specific field and term:

- Bachelor Media Informatics 2020 (compulsory), computer science, 4th semester
- Bachelor Computer Science 2019 (compulsory), foundations of computer science, 4th semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory), computer science, 4th semester
- Bachelor Medical Informatics 2019 (compulsory), computer science, 4th semester
- Bachelor Computer Science 2016 (compulsory), foundations of computer science, 4th semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), computer science, 4th semester
- Bachelor IT-Security 2016 (compulsory), computer science, 4th semester
- Bachelor Media Informatics 2014 (compulsory), foundations of computer science, 4th semester
- Bachelor Medical Informatics 2014 (compulsory), computer science, 4th semester
- Bachelor Computer Science 2014 (compulsory), foundations of computer science, 4th semester

Classes and lectures:

- Lab Course Software Engineering (practical course, 4 SWS)

Workload:

- 60 Hours in-classroom work
- 60 Hours group work
- 50 Hours work on project
- 10 Hours oral presentation and discussion (including preparation)

Contents of teaching:

- Realization of a software system
- Project management and team work
- Design, implementation and testing

Qualification-goals/Competencies:

- The students are able to systematically design software systems whose implemention meets the requirements, using object oriented techniques.
- They can use UML and CASE tools.
- They can decide how to advance their software in a sensible way.
- They can contribute their experience in the realization of a software development project in further projects.
- They have the qualification to present artefacts, to comply tostandards and to observe time limits.
- They are qualified to work in a team and to reflect their social skills.

Grading through:

- continuous, successful participation in practical course
- presentation
- successful addressing of the project goals
- documentation

Requires:

- Introduction to Programming (CS1000-KP10, CS1000SJ14)
- Algorithms and Data Structures (CS1001-KP08, CS1001)
- Software Engineering (CS2300-KP06, CS2300SJ14)

Responsible for this module:

- Prof. Dr. Martin Leucker

Teacher:

- Institute of Software Technology and Programming Languages
- Prof. Dr. Martin Leucker

Literature:

- H. Balzert: Lehrbuch der Softwaretechnik: Softwaremanagement - Spektrum Akademischer Verlag 2008

- B. Brügge, A. H. Dutoit: Objektorientierte Softwaretechnik mit UML, Entwurfsmustern und Java - Pearson Studium 2004
- I. Sommerville: Software Engineering - Addison-Wesley 2012
- B. Oestereich: Analyse und Design mit der UML 2.3 - Objektorientierte Softwareentwicklung - Oldenbourg 2009

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- Passing the module CS2300-KP06 Software Engineering is a prerequisite for taking this module.

It is recommended to take this practical course directly after CS2300-KP06 Software Engineering.

Admission requirements for participation in module examination(s):
- Successful participation in the internship as specified at the beginning of the semester.

Module Exam(s):
- CS2301-L1: Internship Software Engineering, graded internship, 100% of module grade.

MA2510-KP04, MA2510 - Stochastics 1 (Stoch1)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Minor in Teaching Mathematics, Bachelor of Arts 2023 (compulsory), mathematics, 8th semester
- Bachelor CLS 2023 (compulsory), mathematics, 2nd semester
- Bachelor MES 2020 (optional subject), mathematics / natural sciences, 3rd semester at the earliest
- Bachelor Biophysics 2024 (optional subject), mathematics, 6th semester
- Bachelor Computer Science 2019 (compulsory), mathematics, 4th semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory), mathematics, 4th semester
- Bachelor Medical Informatics 2019 (optional subject), mathematics, 4th to 6th semester
- Minor in Teaching Mathematics, Bachelor of Arts 2017 (compulsory), mathematics, 8th semester
- Bachelor Computer Science 2016 (compulsory), mathematics, 4th semester
- Bachelor CLS 2016 (compulsory), mathematics, 2nd semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), mathematics, 4th semester
- Bachelor IT-Security 2016 (compulsory), mathematics, 2nd semester
- Bachelor Biophysics 2016 (optional subject), mathematics, 6th semester
- Bachelor Medical Informatics 2014 (optional subject), mathematics, 5th or 6th semester
- Bachelor MES 2014 (optional subject), mathematics / natural sciences, 4th or 6th semester
- Bachelor Computer Science 2014 (compulsory), mathematics, 4th semester
- Bachelor Computer Science 2012 (compulsory), mathematics, 4th semester
- Bachelor MES 2011 (compulsory), mathematics, 4th semester
- Bachelor CLS 2010 (compulsory), mathematics, 2nd semester

Classes and lectures:

- Stochastics 1 (lecture, 2 SWS)
- Stochastic 1 (exercise, 1 SWS)

Workload:

- 65 Hours private studies and exercises
- 45 Hours in-classroom work
- 10 Hours exam preparation

Contents of teaching:

- probability spaces
- basics of combinatorics
- conditional probability and stochastic independency
- random variables
- important discrete and continuous one-dimensional probability distributions
- characteristics of distributions
- law of large numbers, central limit theorem
- modeling examples from the life sciences

Qualification-goals/Competencies:

- Students are able to explain basic stochastic models formally correct and in the context of their application
- They are able to formalize stochastic problems
- They are able to identify basic combinatorial patterns and to use them for solving stochastic problems
- They understand central statements of elementary stochastics

Grading through:

- written exam

Is requisite for:

- Stochastic processes (MA4610-KP05)
- Stochastic processes and modeling (MA4610-KP04, MA4610)
- Modeling Biological Systems (MA4450-KP08, MA4450-MML)
- Modeling Biological Systems (MA4450-KP07)
- Module part: Modeling Biological Systems (MA4450 T-INF)
- Module part: Modeling Biological Systems (MA4450 T)
- Modeling Biological Systems (MA4450)
- Modeling (MA4449-KP07)

- Module part: Stochastics 2 (MA4020 T)
- Stochastics 2 (MA4020-KP05)
- Stochastics 2 (MA4020-MML)
- Stochastics 2 (MA4020-KP04, MA4020)

Responsible for this module:

- Nachfolge von Prof. Dr. rer. nat. Karsten Keller

Teacher:

- Institute for Mathematics
- Nachfolge von Prof. Dr. rer. nat. Karsten Keller

Literature:

- N. Henze: Stochastik für Einsteiger - Vieweg
- U. Krengel: Einführung in die Wahrscheinlichkeitstheorie - Vieweg

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of homework assignments during the semester

Module exam(s):
- MA2510-L1: Stochastics 1, written exam, 90 min, 100 % of module grade

ME2700-KP08, ME2700 - Fundamentals of Electrical Engineering 2 (ETechnik2)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	8

Course of study, specific field and term:

- Bachelor Computer Science 2019 (optional subject), Extended optional subjects, Arbitrary semester
- Bachelor MES 2020 (compulsory), electrical engineering, 4th semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory), electrical engineering, 4th semester
- Bachelor MES 2011 (optional subject), electrical engineering, 4th to 6th semester
- Bachelor Computer Science 2016 (optional subject), advanced curriculum, Arbitrary semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 4th semester
- Bachelor MES 2014 (compulsory), electrical engineering, 4th semester

Classes and lectures:

- Fundamentals of Electrical Engineering 2 (lecture, 4 SWS)
- Fundamentals of Electrical Engineering 2 (exercise, 2 SWS)

Workload:

- 125 Hours private studies
- 90 Hours in-classroom work
- 25 Hours exam preparation

Contents of teaching:

- Periodic and non-periodic waveforms
- Transient response of basic linear circuits
- AC circuit analysis
- Frequency responses and Nyquist plot
- Physical basics of semiconductors
- Diodes
- Bipolar Transistors
- Field-effect transistors
- Operational amplifier
- Integrated circuits
- AD and DA converter
- Basic electronic circuits
- Introduction into the simulation of electrical circuits

Qualification-goals/Competencies:

- Students know and understand the basics of AC circuit analysis and know how to apply it.
- Students can assess frequency response plots of electrical circuits and evaluate their consequences.
- Students can develop and analyze active and passive analog filters.
- Students know the main semiconductor elements and their basic circuits.
- Students recognize and understand the most relevant electronic circuits.
- Students can design and modify their own circuits by modifying and combining elementary circuits.
- Students are capable of simulating electrical circuits and know how to use basic features of the PSpice simulator.

Grading through:

- Written or oral exam as announced by the examiner

Is requisite for:

- Medical Electrical Engineering Lab Course (ME3400-KP04, ME3400)

Requires:

- Fundamentals of Electrical Engineering 1 (ME2400-KP08, ME2400)

Responsible for this module:

- Prof. Dr. Philipp Rostalski

Teacher:

- Institute for Electrical Engineering in Medicine
- Prof. Dr. Philipp Rostalski

Literature:

- Agarwal, Lang: Foundations of Analog and Digital Circuits - Elsevier; ISBN: 1-55860-735-8
- S. Goßner: Grundlagen der Elektronik. Halbleiter, Bauelemente und Schaltungen - ISBN: 3826588258

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None (the competencies of the modules listed under

CS1002-KP04, CS1002 - Introduction to Logics (Logik)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Bachelor MES 2014 (optional subject), computer science / electrical engineering, 3rd semester at the earliest
- Bachelor Media Informatics 2020 (compulsory), computer science, 2nd semester
- Bachelor Computer Science 2019 (compulsory), foundations of computer science, 2nd semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 5th or 6th semester
- Bachelor Medical Informatics 2019 (compulsory), computer science, 2nd semester
- Bachelor Media Informatics 2014 (optional subject), computer science, 5th or 6th semester
- Bachelor Computer Science 2016 (compulsory), foundations of computer science, 3rd semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester
- Bachelor IT-Security 2016 (compulsory), computer science, 2nd semester
- Bachelor Medical Informatics 2014 (compulsory), computer science, 3rd semester
- Bachelor Computer Science 2014 (compulsory), foundations of computer science, 3rd semester
- Bachelor Medical Informatics 2011 (compulsory), computer science, 1st semester
- Bachelor MES 2011 (optional subject), computer science, 3rd semester
- Bachelor CLS 2010 (optional subject), computer science, 6th semester
- Bachelor Computer Science 2012 (compulsory), foundations of computer science, 1st semester
- Bachelor Biophysics 2024 (optional subject), computer science, 6th semester

Classes and lectures:

- Introduction to Logic (lecture, 2 SWS)
- Introduction to Logic (exercise, 1 SWS)

Workload:

- 65 Hours private studies and exercises
- 45 Hours in-classroom work
- 10 Hours exam preparation

Contents of teaching:

- Key concepts of syntax: alphabet, string, term, formula
- Key concepts of semantics: assignment, structure, model
- Key concepts of proof calculus: axioms, proofs
- Formlization and coding of problems
- Validating correctness and satisfiability of formalizations
- Syntax and semantics of propositional logic
- Syntax and semantics of predicate logig
- Proof caculi

Qualification-goals/Competencies:

- Students are abel to explain the concepts of syntax and semantics for the examples of prepositional and predicate logic
- They are able to apply formal systems and proof systems
- They are able to transfer methods of mathematical logic to simple practical problems
- They are abel to formalize discrete problems
- They are able to modify proof templates in order to create simple proofs

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Till Tantau

Teacher:

- Institute for Theoretical Computer Science

- Prof. Dr. rer. nat. Till Tantau
- Prof. Dr. Rüdiger Reischuk

Literature:

- Uwe Schöning: Logik für Informatiker - Spektrum Verlag, 1995

- Kreuzer, Kühlig: Logik für Informatiker - Pearson Studium, 2006

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of exercise slips as specified at the beginning of the semester.

Module Exam(s):
- CS1002-L1: Introduction to Logic, portfolio exam: a total of 70 points for written exercises down during the course of the semester, 30 points for the written exam at the end. The grade is calculated as follows: 50 to 54 points for a 4.0, then 55 to 59 points for a 3.7 and so on until the end 95 to 100 points for a 1.0.

CS1300-KP04, CS1300 - Introduction to Medical Informatics (EMI)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Bachelor IT-Security 2016 (optional subject), interdisciplinary, Arbitrary semester
- Bachelor Computer Science 2019 (optional subject), Introductory Module Computer Science, 1st semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), medical computer science, 5th or 6th semester
- Bachelor Medical Informatics 2019 (compulsory: aptitude test), medical computer science, 1st semester
- Bachelor Computer Science 2016 (optional subject), Introductory Module Computer Science, 1st semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester
- Bachelor Medical Informatics 2014 (compulsory: aptitude test), medical computer science, 1st semester
- Bachelor Medical Informatics 2011 (compulsory: aptitude test), medical computer science, 1st semester
- Bachelor CLS 2010 (optional subject), computer science, 5th semester
- Bachelor MES 2011 (compulsory), foundations of computer science, 3rd semester
- Bachelor Computer Science 2012 (compulsory), specialization field medical informatics, 1st semester

Classes and lectures:

- Introduction to Medical Informatics (lecture, 2 SWS)
- Introduction to Medical Informatics (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Basic concepts and methods of medical informatics
- Overview of the occupational field in medical informatics
- Introduction to the German healthcare system
- Introduction to medical documentation, including patient record
- Information systems in the healthcare sector
- Conceptual systems in medicine (classifications, terminologies)
- Medical informatics in clinical practice
- Principles of medical imaging: X-ray, ultrasound, CT, MRI
- Fundamentals of medical image computing and visualisation
- Medical sensor data analysis
- Medical decision support for diagnostics and therapy
- Health telematics
- Medical data security

Qualification-goals/Competencies:

- Students know the fundamental terms and selected methods in the area of medical informatics.
- They know the main features of the German healthcare system.
- They are able to formulate the objectives and types of medical documentation including the electronic health record.
- They know the requirements for clinical information systems.
- They are able to formulate SQL queries and apply them to relational databases.
- They are able to explain the principles of medical imaging.
- They are able to explain the fundamentals of medical image processing and visualisation.
- They know selected application scenarios in the area of medical sensor data analysis.
- They know selected approaches for medical decision support.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. habil. Heinz Handels

Teacher:

- Institute of Medical Informatics
- Prof. Dr. rer. nat. habil. Heinz Handels

- Prof. Dr.-Ing. Marcin Grzegorzek
- Prof. Dr. Mattias Heinrich

Literature:

- Th. Lehmann: Handbuch der Medizinischen Informatik - 2nd Edition, München: Hanser 2004
- P. Haas: Medizinische Informationssysteme und Elektronische Krankenakten - Berlin: Springer 2005
- F. Leiner, W. Gaus, R. Haux: Medizinische Dokumentation - 4th Edition, Stuttgart: Schattauer 2003

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of exercise slips as specified at the beginning of the semester
- Giving a short lecture as specified at the beginning of the semester

Module examinations:
- CS1300-L1: Introduction to Medical Informatics, written exam, 90min, 100% of module grade

CS2000-KP08, CS2000 - Theoretical Computer Science (TI)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	8

Course of study, specific field and term:

- Bachelor Media Informatics 2020 (compulsory), computer science, 3rd semester
- Bachelor Computer Science 2019 (compulsory), foundations of computer science, 3rd semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 5th or 6th semester
- Bachelor Medical Informatics 2019 (compulsory), computer science, 3rd semester
- Bachelor Computer Science 2016 (compulsory), foundations of computer science, 3rd semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester
- Bachelor IT-Security 2016 (compulsory), computer science, 3rd semester
- Bachelor MES 2011 (optional subject), computer science, 5th semester
- Bachelor Medical Informatics 2014 (compulsory), computer science, 3rd semester
- Bachelor Computer Science 2014 (compulsory), foundations of computer science, 3rd semester
- Bachelor Media Informatics 2014 (compulsory), computer science, 3rd semester
- Bachelor Medical Informatics 2011 (compulsory), computer science, 3rd semester
- Bachelor Computer Science 2012 (compulsory), foundations of computer science, 3rd semester

Classes and lectures:

- Theoretical Computer Science (lecture, 4 SWS)
- Theoretical Computer Science (exercise, 2 SWS)

Workload:

- 135 Hours private studies and exercises
- 90 Hours in-classroom work
- 15 Hours exam preparation

Contents of teaching:

- Formalization of problems using languages
- formal grammars
- regular languages, finite automata
- context free language, push down automata
- sequential computational models: Turing machines, register machines
- sequential complexity classes
- simulations, reductions, completeness
- satisfiability problem, NP-completeness
- (In-)decidability and enumerability
- halting problem and Church-Turing thesis

Qualification-goals/Competencies:

- Students are able to present the theoretical foundation of syntax and operational semantics of programming languages
- They are able to transform formalizations using theorems of theoretical computer science.
- They can classify problems according to their computational complexity
- They are able to model algorithmic problems and solve them using appropriate tools
- They can judge what computer science can and cannot achieve in principle

Grading through:

- written exam and course achievements

Is requisite for:

- Parallel Computing (CS3051-KP04, CS3051)

Requires:

- Algorithms and Data Structures (CS1001-KP08, CS1001)
- Introduction to Programming (CS1000-KP08, CS1000SJ14-MML/MI, CS1000SJ14-MIW)
- Introduction to Programming (CS1000-KP10, CS1000SJ14)

Responsible for this module:

- Prof. Dr. Rüdiger Reischuk

Teacher:

- Institute for Theoretical Computer Science

- Prof. Dr. Rüdiger Reischuk
- Prof. Dr. rer. nat. Till Tantau
- Prof. Dr. Maciej Liskiewicz

Literature:

- J. Hopcroft, R. Motwani, J. Ullman: Introduction to Automata Theory, Languages and Computation - Addison Wesley, 2001

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None (the competences of the modules indicated under

CS2101-KP04, CS2101 - Embedded Systems (ES)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Bachelor Robotics and Autonomous Systems 2020 (optional subject), Additionally recognized elective module, Arbitrary semester
- Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Computer Science 2019 (optional subject), Canonical Specialization SSE, 6th semester
- Bachelor MES 2020 (optional subject), computer science / electrical engineering, 3rd semester at the earliest
- Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester
- Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Computer Science 2016 (optional subject), Canonical Specialization SSE, 6th semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester
- Bachelor IT-Security 2016 (optional subject), computer science, Arbitrary semester
- Bachelor Biophysics 2016 (optional subject), computer science, 6th semester
- Bachelor Medical Informatics 2014 (optional subject), computer science, 5th or 6th semester
- Bachelor MES 2014 (optional subject), computer science / electrical engineering, 4th or 6th semester
- Bachelor Computer Science 2014 (optional subject), central topics of computer science, 6th semester
- Bachelor Computer Science 2014 (compulsory), specialization field robotics and automation, 4th semester
- Bachelor Medical Informatics 2011 (optional subject), computer science, 4th to 6th semester
- Bachelor MES 2011 (compulsory), computer system science, 6th semester
- Bachelor Biophysics 2024 (optional subject), computer science, 6th semester

Classes and lectures:

- Embedded Systems (lecture, 2 SWS)
- Embedded Systems (exercise, 1 SWS)

Workload:

- 60 Hours private studies and exercises
- 45 Hours in-classroom work
- 15 Hours exam preparation

Contents of teaching:

- Target architectures (microcontrollers, FPGAs etc.)
- Conceptional models
- Peripheral buses
- Scheduling algorithms and real-time operating systems
- Specification languages
- Transformation from specification to implementation
- Development tools
- Programming of embedded systems using C

Qualification-goals/Competencies:

- Students are able to explain the differences between desktop systems and embedded systems.
- They are able to select an appropriate hardware architecture for an embedded system.
- They are able to select appropriate communication protocols for interfacing peripheral components.
- They are able to control peripheral components with a microcontroller.
- They are able to model embedded systems conceptually and to specify them formally.
- They are well acquainted with the model-based design and tool-based implementation and of simple embedded systems.
- They can independently implement the specifications of the embedded system through C programming
- They can use real-time operating systems to implement embedded systems with real-time capability and deterministic time behavior

Grading through:

- written exam

Requires:

- Introduction to Programming (CS1000-KP10, CS1000SJ14)
- Fundamentals of Computer Engineering 1 (CS1200-KP06, CS1200SJ14)

Responsible for this module:

- Prof. Dr.-Ing. Mladen Berekovic

Teacher:

- Institute of Computer Engineering
- Prof. Dr.-Ing. Mladen Berekovic

Literature:

- P. Marwedel: Eingebettete Systeme - Berlin: Springer 2007
- W. Wolf: Computers as Components - Principles of Embedded Computing System Design - San Francisco: Morgan Kaufmann 2012
- D.D. Gajski, F. Vahid, S. Narayan, J. Gong: Specification and Design of Embedded Systems - Englewood Cliffs: Prentice Hall 1994
- U. Brinkschulte, T. Ungerer: Mikrocontroller und Mikroprozessoren - Berlin: Springer 2010
- H. Woern, U. Brinkschulte: Echtzeitsysteme - Berlin: Springer 2005

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None (the competencies of the modules listed under

CS2600-KP08, CS2600SJ14 - Interaction Design and User Experience (IDE)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	8

Course of study, specific field and term:

- Bachelor Media Informatics 2020 (compulsory), design, 4th semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 5th or 6th semester
- Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester
- Bachelor Computer Science 2014 (optional subject), central topics of computer science, 6th semester
- Bachelor Media Informatics 2014 (compulsory), media informatics, 4th semester

Classes and lectures:

- Interaction Design (lecture, 4 SWS)
- Interaction Design (exercise, 2 SWS)

Workload:

- 120 Hours private studies
- 90 Hours in-classroom work
- 30 Hours exam preparation

Contents of teaching:

- Introduction and overview
- A short history of Human Computer Interaction (
- Definition and distinction: Software Ergonomics vs Usability Engineering vs Interaction Design
- Usability as design goal: central models and ISO norms, fundamentals of software ergonomic and cognition (a brief review of Software Ergonomics)
- User Experience (UX) as new design goal: Models and background (i.e. pleasurable products, hedonistic and pragmatic quality, emotional design)
- UX as aesthetic and emotional appeal
- UX as ergonomic factor, dark patterns
- Process models for Interaction Design: From Human-Centered Design based on the ISO-Norm to the simplified Four-Phase-Model
- Iterative Design as mental models in action: Design Model, User Model and System Image
- Phase 1 of Interaction Design: 'Understand' (Practical methods of design ethnography and context analysis; representation of users and tasks)
- Phase 2 of Interaction Design: 'design' (system's paradigms: HCI as conversation, HCI as model-world, Direct Manipulation, Tangible Interaction, Proxemic Interaction, Virtual Reality; Sketching User Experiences for idea generation and solution development; design principles and guidelines as decision support, i.e. Normans' principles, gestalt laws, Human Interface Guidelines; theoretical models and techniques from research vs. design practice)
- Phase 3 of Interaction Design 'Build' (basic principles of Prototyping; Low- vs. High-Fidelity-Prototyping; Time vs. Fidelity: Sketching, Paper Prototyping, Wireframes/Click-Through, Dynamic Prototypes, Coded Prototypes; Prototyping tools in practice)
- Phase 4 of interaction design: 'evaluate' (analytic vs empirical methods in practicse; evaluation of users experience with standardized questionnaires; formative vs. summative evaluation; usability tests, A/B studies; Continuous processes for quality control resp. UX evaluation)
- Post WIMP interaction: Interaction Design beyond PC and Smartphone

Qualification-goals/Competencies:

- The students are able to use systematically and theoretically founded methods for the design of user interfaces of interactive systems.
- The students are able to use their knowledge in Software Ergonomics, Media Design and Media Informatics in a realistic Interaction Design project
- They are capable of categorizing existing systems and develop concepts for improving them.
- They are capable of planning and designing human-computer interfaces with high user experience.

Grading through:

- portfolio exam - the concrete examination elements and their weights will be published in the course
-

Requires:

- Software Ergonomics (CS2200-KP04, CS2200)
- Introduction to Media Informatics (CS1600-KP04, CS1600)

Responsible for this module:

- Prof. Dr. rer. nat. Hans-Christian Jetter

Teacher:

- Institute for Multimedia and Interactive Systems
- Prof. Dr. rer. nat. Hans-Christian Jetter
- MitarbeiterInnen des Instituts

Literature:

- H. Sharp, J. Preece, Y. Rogers: Interaction Design: Beyond Human-Computer Interaction - Wiley, 2019
- R. Hartson, P. Pyla: The UX Book: Agile UX Design for a Quality User Experience - Morgan Kaufman, 2019
- Michael Richter, Markus Flückiger: Usability und UX kompakt - Produkte für Menschen, 2015
- Saul Greenberg, Sheelagh Carpendale, Nicolai Marquardt, Bill Buxton: Sketching User Experiences - The Workbook, 2012

Language:

- offered only in German

Notes:

Admission requirements for taking the module
- None (the competences of the modules mentioned under Requires are needed for this module, but are not a formal prerequisite).

Admission requirements for participation in module examination(s):
- Preliminary examinations may be required and will be announced at the beginning of the semester.

Module Exam(s):
- CS2600-L1 Interaction Design and User Experience, oral exam, 50% of the module grade
- CS2600-L1 Interaction Design and User Experience, portfolio exam, 50% of the module grade during the semester

Replaces CS2600-KP08 Interaction Design

CS2700-KP04, CS2700 - Databases (DB)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Bachelor Biophysics 2024 (optional subject), computer science, 6th semester
- Bachelor MES 2020 (optional subject), computer science / electrical engineering, 3rd semester at the earliest
- Bachelor Media Informatics 2020 (compulsory), computer science, 5th semester
- Bachelor Computer Science 2019 (compulsory), foundations of computer science, 3rd semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 5th or 6th semester
- Bachelor Medical Informatics 2019 (compulsory), computer science, 3rd semester
- Bachelor Computer Science 2016 (compulsory), foundations of computer science, 4th semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester
- Bachelor IT-Security 2016 (compulsory), computer science, 3rd semester
- Bachelor Biophysics 2016 (optional subject), computer science, 6th semester
- Bachelor MES 2011 (optional subject), computer science, 4th or 6th semester
- Bachelor Medical Informatics 2014 (compulsory), computer science, 4th semester
- Bachelor MES 2014 (optional subject), computer science / electrical engineering, 4th or 6th semester
- Bachelor Media Informatics 2014 (compulsory), foundations of computer science, 4th semester
- Bachelor Computer Science 2014 (compulsory), foundations of computer science, 4th semester
- Bachelor Medical Informatics 2011 (compulsory), computer science, 2nd semester
- Master CLS 2010 (optional subject), computer science, 2nd semester
- Bachelor CLS 2010 (optional subject), computer science, 6th semester
- Bachelor Computer Science 2012 (compulsory), foundations of computer science, 4th semester

Classes and lectures:

- Databases (lecture, 2 SWS)
- Databases (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Introduction, conceptual view of database systems, conceptual data modeling with the Entity-Relationship (ER) modeling language
- The relational data model* Referential integrity, keys, foreign keys, functional dependencies (FDs)* Canonical mapping of entity types and relationships into the relational data model* Update, insertions, and deletion anomalies* Relational algebra as a query language* Database normalization, closure w.r.t. FD set, canonical cover of FD sets, normal forms, correct and dependency preserving decomposition of relation schemata, multi-value dependencies, inclusion dependencies
- Practical query language: SQL* Selection, projection, join, aggregation, grouping, sorting, difference, relational algebra in SQL* Data management* Integrity constraints
- Storage structures and database architecture* Characteristics of storage media, I/O complexity* DBMS architecture: disk space manager, buffer manager, files and access methods, record allocation strategies (row-wise, column-wise, mixed)
- Query processing* Indexing techniques, ISAM index, B+-tree index, hash index* Sorting: Two-way merge sort, blockwise processing, selection trees, query execution plans, join operator: nested loops join, blockwise nested loops join, index-based joins, sort-merge join, partition-based join with hashing* Addition operators: grouping and duplicate elimination, selection, projection, pipeline principle
- Datalog* Syntax, semantics, treatment of negation (stratification)* Evaluation strategies (naive, semi naive, magic set transformation)
- Query optimization* Cost metrics, Estimating sizes of intermediate tables, selectivity* Join optimization, physical plan properties, interesting orders, query transformation* Index cuts, bitmap indexes
- Transactions and recovery* ACID, anomalies, serializability, locks, 2-phase commit protocol, concurrent access to index structures, isolation levels* Implementation of transaction w.r.t. ACID, shadow pages, write ahead log, snapshots

Qualification-goals/Competencies:

- For all subjects mentioned in the course contents under the indents students should name the central ideas, which can define relevant terms and explain the functioning of algorithms by means of application examples.

Grading through:

- written exam

Is requisite for:

- Nonstandard Databases and Data Mining (CS3130-KP08)

- Nonstandard Database Systems (CS3202-KP04, CS3202)

Requires:

- Algorithms and Data Structures (CS1001-KP08, CS1001)
- Introduction to Programming (CS1000-KP08, CS1000SJ14-MML/MI, CS1000SJ14-MIW)
- Introduction to Programming (CS1000-KP10, CS1000SJ14)

Responsible for this module:

- Prof. Dr. Sven Groppe

Teacher:

- Institute of Information Systems
- Prof. Dr. Sven Groppe

Literature:

- A. Kemper, A, Eickler: Datenbanksysteme - Eine Einführung - Oldenbourg-Verlag

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None (the competences of the modules mentioned under "requires" are needed for this module, but are not a formal prerequisite).

Admission requirements for participation in module examination(s):
- Successful completion of exercise sheets as specified at the beginning of the semester.

Module Exam(s):
- CS2700-L1: Databases, written exam, 90min, 100% of the module grade.

CS3000-KP04, CS3000 - Algorithm Design (AlgoDesign)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Master CLS 2023 (optional subject), computer science, 3rd semester
- Bachelor Computer Science 2019 (compulsory), foundations of computer science, 5th semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 5th or 6th semester
- Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester
- Bachelor Computer Science 2016 (compulsory), foundations of computer science, 5th semester
- Master CLS 2016 (optional subject), computer science, 3rd semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester
- Bachelor IT-Security 2016 (compulsory), computer science, 5th semester
- Bachelor Medical Informatics 2014 (optional subject), computer science, 5th or 6th semester
- Bachelor Computer Science 2014 (compulsory), foundations of computer science, 5th semester
- Bachelor CLS 2010 (optional subject), computer science, 5th or 6th semester
- Bachelor Computer Science 2012 (compulsory), foundations of computer science, 5th semester

Classes and lectures:

- Algorithm Design (lecture, 2 SWS)
- Algorithm Design (exercise, 1 SWS)

Workload:

- 65 Hours private studies and exercises
- 45 Hours in-classroom work
- 10 Hours exam preparation

Contents of teaching:

- Dynamic programming and heuristic search methods
- Complex data structures and union find data structures
- Efficiency analysis and correctness proofs
- Probabilistic algorithms
- Online algorithms
- Graph, matching and scheduling problems
- String processing
- Approximation algorithms

Qualification-goals/Competencies:

- The students can safely apply the principles of algorithm design.
- They can analyze algorithms with respect to correctness and efficiency.
- They are able to apply these principles to concrete problems.
- They can contribute their proficiency in solving similar algorithmic problems.

Grading through:

- written exam

Requires:

- Stochastics 1 (MA2510-KP04, MA2510)
- Theoretical Computer Science (CS2000-KP08, CS2000)
- Algorithms and Data Structures (CS1001-KP08, CS1001)

Responsible for this module:

- Prof. Dr. Rüdiger Reischuk

Teacher:

- Institute for Theoretical Computer Science
- Prof. Dr. Rüdiger Reischuk
- Prof. Dr. rer. nat. Till Tantau

Literature:

- J. Kleinberg, E. Tardos: Algorithm Design - Addison Wesley, 2005

- T. Cormen, C. Leiserson, R. Rivest, C. Stein: Introduction to Algorithms - MIT Press, 2009
- S. Skiena: The Algorithmic Design Manual - Springer, 2012

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None (The competencies of the modules listed under 'Requires' are needed for this module, but are not a formal prerequisite)

Prerequisites for the exam:
- Successful completion of homework and project assignments as specified at the beginning of the semester.

Module exam(s):
- CS3000-L1: Algorithm Design, written exam, 90 min, 100 % of module grade

CS3010-KP04, CS3010 - Human-Computer-Interaction (MCI)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (optional subject), interdisciplinary competence, Arbitrary semester
- Bachelor Computer Science 2019 (compulsory), foundations of computer science, 5th semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 5th or 6th semester
- Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester
- Master Biophysics 2019 (optional subject), Elective, 1st semester
- Master Psychology 2016 (optional subject), interdisciplinary competence, 3rd semester at the earliest
- Bachelor Computer Science 2016 (compulsory), foundations of computer science, 5th semester
- Bachelor IT-Security 2016 (compulsory), computer science, 3rd semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester
- Master Entrepreneurship in Digital Technologies 2014 (optional subject), interdisciplinary competence, Arbitrary semester
- Master psychology 2013 (optional subject), interdisciplinary competence, 3rd semester
- Master Medical Informatics 2014 (optional subject), computer science, 1st or 2nd semester
- Bachelor Computer Science 2014 (compulsory), foundations of computer science, 5th semester
- Bachelor Medical Informatics 2014 (optional subject), computer science, 5th or 6th semester

Classes and lectures:

- Human-Computer-Interaction (lecture, 2 SWS)
- Human-Computer-Interaction (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Introduction and overview of the topic area
- Norms and legal foundations
- Human information processing and processes of actions
- Models for human-computer systems and interactive media
- Input/Output devices and interaction technologies
- User-centered development process and special groups of users
- Usability Engineering
- System paradigms and corresponding system examples
- Evaluation and impact analyzes
- Innovative concepts and systems

Qualification-goals/Competencies:

- The students know the principles and methods of the context-, task- and user-centered development of interactive systems.
- They have basic knowledge about human information processing and can introduce it into the design process.
- They know the basic models of interactive systems und can apply them for their analysis and evaluation.
- They have the ability to analyze and review interative systems based on criteria.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. phil. André Calero Valdez

Teacher:

- Institute for Multimedia and Interactive Systems
- Prof. Dr. phil. André Calero Valdez

Literature:

- M. Dahm: Grundlagen der Mensch-Computer-Interaktion - Pearson Studium, 2006
- J.A. Jacko: The Human-Computer Interaction Handbook - CRC Press, 2012

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Successful completion of homework assignments as stated in the beginning of the course

Exam(s):
- CS3010-L1 Mensch-Computer-Interaktion, Klausur, 90min, 100% der Modulnote

CS3051-KP04, CS3051 - Parallel Computing (ParallelVa)

Duration:	Turnus of offer:	Credit points:
1 Semester	normally each year in the summer semester	4

Course of study, specific field and term:

- Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Computer Science 2019 (optional subject), Canonical Specialization SSE, 4th semester
- Bachelor Media Informatics 2020 (optional subject), computer science, 5th or 6th semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 5th or 6th semester
- Bachelor Computer Science 2016 (optional subject), Canonical Specialization Web and Data Science, 4th semester
- Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Computer Science 2016 (optional subject), Canonical Specialization SSE, 4th semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester
- Bachelor IT-Security 2016 (optional subject), computer science, Arbitrary semester
- Master Medical Informatics 2014 (optional subject), computer science, 1st or 2nd semester
- Bachelor Computer Science 2014 (optional subject), central topics of computer science, 5th or 6th semester
- Master Computer Science 2012 (optional subject), advanced curriculum programming, 2nd and 3rd semester
- Bachelor Computer Science 2012 (optional subject), central topics of computer science, 5th or 6th semester
- Master Computer Science 2012 (optional subject), advanced curriculum algorithmics and complexity theory, 2nd or 3rd semester

Classes and lectures:

- Parallel Computing (lecture, 2 SWS)
- Parallel Computing (exercise, 1 SWS)

Workload:

- 65 Hours private studies and exercises
- 45 Hours in-classroom work
- 10 Hours exam preparation

Contents of teaching:

- Parallel architectures
- Programming language support for parallel programming
- Design methodologies for parallel algorithms
- Implementation of parallel algorithms
- Parallel search and sorting
- Parallel graph algorithms
- Parallel formula evaluation
- Speedup, efficiency, parallel complexity classes
- Limits of parallelism and lower bounds

Qualification-goals/Competencies:

- Studentes are able to describe the design and function of parallel systems.
- They are able to design and implement parallel algorithms.
- They are able to analyze parallel systems and programs.
- They are able to describe the limits of parallel systems.

Grading through:

- Viva Voce or test

Requires:

- Theoretical Computer Science (CS2000-KP08, CS2000)

Responsible for this module:

- Prof. Dr. rer. nat. Till Tantau

Teacher:

- Institute for Theoretical Computer Science
- Prof. Dr. rer. nat. Till Tantau

Literature:

- Jaja: An Introduction to Parallel Algorithms - Addison Wesley, 1992

- Quinn: Parallel Programming in C with MPI and OpenMP - McGraw Hill, 2004

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None (the competencies of the modules listed under

CS3110-KP04, CS3110 - Computer-Aided Design of Digital Circuits (SchaltEntw)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Master Robotics and Autonomous Systems 2019 (optional subject), Additionally recognized elective module, Arbitrary semester
- Master MES 2020 (optional subject), computer science / electrical engineering, Arbitrary semester
- Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester
- Bachelor IT-Security 2016 (optional subject), computer science, Arbitrary semester
- Bachelor MES 2014 (optional subject), computer science / electrical engineering, 5th or 6th semester
- Bachelor Computer Science 2014 (optional subject), central topics of computer science, 5th or 6th semester
- Bachelor MES 2011 (optional subject), Applied computer science, 3rd, 5th, or 6th semester
- Bachelor CLS 2010 (optional subject), computer science, 5th or 6th semester
- Bachelor Computer Science 2012 (optional subject), central topics of computer science, 5th or 6th semester

Classes and lectures:

- Computer-Aided Design of Digital Circuits (lecture, 2 SWS)
- Computer-Aided Design of Digital Circuits (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Abstraction levels in circuit design
- Design cycle and design strategies
- FPGA architectures
- Introduction of the hardware description language VHDL
- Design of standard components in VHDL
- Circuit design at different abstraction levels
- Circuit design for synthesis
- VHDL simulation cycle
- VHDL circuit design for FPGAs
- Designing Testbenches
- High-Level-Synthesis

Qualification-goals/Competencies:

- Based on a non-formal description of a digital system, students are able to design digital circuits using VHDL
- They are able to simulate and test VHDL descriptions
- They are able to explain the internal structures of FPGAs
- They are able to determine which VHDL construct will result in which circuit structure
- They are able to explain the VHDL simulation cycle
- They are able to write synthesizable VHDL code

Grading through:

- written exam

Responsible for this module:

- Prof. Dr.-Ing. Mladen Berekovic

Teacher:

- Institute of Computer Engineering
- Prof. Dr.-Ing. Mladen Berekovic

Literature:

- F. Kesel, R. Bartholomä: Entwurf von digitalen Schaltungen und Systemen mit HDLs und FPGAs - Oldenbour Verlag 2009
- C.Maxfield: The Design Warrior's Guide to FPGAs - Newnes 2004

Language:

- English, except in case of only German-speaking participants

Notes:

Admission requirements for taking the module:
- None

CS3201-KP04, CS3201 - Usability Engineering (UsabUXEng)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Bachelor Media Informatics 2020 (compulsory), media informatics, 5th semester
- Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Computer Science 2019 (compulsory), Canonical Specialization SSE, 5th semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 5th or 6th semester
- Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Computer Science 2016 (compulsory), Canonical Specialization SSE, 5th semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester
- Bachelor IT-Security 2016 (optional subject), computer science, Arbitrary semester
- Bachelor Media Informatics 2014 (compulsory), media informatics, 5th semester
- Bachelor Computer Science 2014 (optional subject), central topics of computer science, 5th semester
- Bachelor Medical Informatics 2011 (optional subject), software engineering, 4th to 6th semester
- Bachelor Computer Science 2012 (compulsory), specialization field media informatics, 6th semester
- Bachelor Computer Science 2012 (optional subject), central topics of computer science, 6th semester

Classes and lectures:

- Usability Engineering (lecture, 2 SWS)
- Usability-Engineering (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Introduction and motivation
- Software- und Usability-Engineering
- Usability and UX target criteria for interactive systems
- Cost-benefit analysis
- Design and conception methods for user experience
- Organizational and context analysis
- User analyses
- Task analyses
- Modeling and design of interactive systems
- Evaluation of interactive systems: planning, implementation and evaluation
- Statistical methods of usability and UX evaluation
- Interdisciplinary teams and social processes
- Embedding usability and UX in business processes

Qualification-goals/Competencies:

- Students can explain and implement the basic human-centered development processes for multimedia interactive systems.
- You can adapt and apply the basic processes for development projects to suit the problem.
- They can apply usability and user experience engineering methods in a targeted manner and evaluate, reflect on and communicate their results.
- They can justify the influence of formal and informal requirements as well as complex social structures and behaviors on human-centered development processes.
- The exercise trains team skills, structured work, time management and presentation skills.

Grading through:

- written exam

Requires:

- Software Ergonomics (CS2200-KP04, CS2200)

Responsible for this module:

- Prof. Dr. phil. André Calero Valdez

Teacher:

- Institute for Multimedia and Interactive Systems
- Prof. Dr. phil. André Calero Valdez

Literature:

- Deborah J. Mayhew: The Usability Engineering Lifecycle - Morgan Kaufmann Publ., 1999
- Jeff Sauro, James R. Lewis: Quantifying the User Experience - Morgan Kaufmann Publ., 2016
- Karen Holtzblatt, Hugh Beyer: Contextual Design. Defining Customer-Centered Systems - Morgan Kaufmann Publ., 1997

Language:

- offered only in German

Notes:

Replaces CS3201-KP04 Usability-Engineering.

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Successful completion of homework assignments as stated at the beginning of the course

Exam(s):
- CS3201-L1 Usability- und UX-Engineering, Klausur, 90min, 100% der Modulnote

CS3205-KP04, CS3205 - Computer Graphics (CompGrafik)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester
- Bachelor MES 2020 (optional subject), computer science / electrical engineering, 3rd semester at the earliest
- Bachelor Media Informatics 2020 (compulsory), media informatics, 6th semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 5th or 6th semester
- Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester
- Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester
- Bachelor IT-Security 2016 (optional subject), computer science, Arbitrary semester
- Bachelor Medical Informatics 2014 (optional subject), computer science, 5th or 6th semester
- Bachelor MES 2014 (optional subject), computer science / electrical engineering, 4th or 6th semester
- Bachelor Media Informatics 2014 (compulsory), media informatics, 6th semester
- Bachelor Computer Science 2014 (optional subject), central topics of computer science, 5th or 6th semester
- Bachelor Medical Informatics 2011 (optional subject), computer science, 4th to 6th semester
- Master Computer Science 2012 (optional subject), advanced curriculum imaging systems, 2nd or 3rd semester
- Bachelor CLS 2010 (optional subject), mathematics, 6th semester
- Bachelor Computer Science 2012 (optional subject), central topics of computer science, 5th or 6th semester
- Master CLS 2010 (optional subject), mathematics, 2nd semester
- Bachelor Computer Science 2012 (compulsory), specialization field media informatics, 5th or 6th semester

Classes and lectures:

- Computer Graphics (lecture, 2 SWS)
- Computer Graphics (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Geometric transformations in 2D and 3D
- Homogeneous coordinates
- Transformations between Cartesian coordinate systems
- Planar and perspective projections
- Polygonal models
- Illumination models and shading methods
- Texture Mapping
- Culling and clipping
- Hidden line and surface removal
- Raster graphics algorithms
- Ray tracing
- Shadows, reflections and transparency
- Basics of graphics programming with OpenGL and GLSL

Qualification-goals/Competencies:

- Students know the basic concepts, algorithms and methods in computer graphics
- They are able to implement and apply principle algorithms
- They are able to explain the learned techniques and to assess their possibilities and limitations

Grading through:

- written exam

Requires:

- Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500)
- Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000)

Responsible for this module:

- Prof. Dr. rer. nat. habil. Heinz Handels

Teacher:

- Institute of Medical Informatics
- Dr. rer. nat. Jan Ehrhardt

Literature:

- Foley et. al: Grundlagen der Computergrafik - Addison-Wesley, 1994

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None (the competences of the modules listed under "requires" are needed for this module, but are not a formal prerequisite)

Admission requirements for participation in module examination(s):
- Successful completion of exercise slips and programming projects as specified at the beginning of the semester

Module exam(s):
- CS3205-L1: Computer Graphics, written exam, 90 min, 100 % of module grade

CS3206-KP04, CS3206 - Compiler Construction (Compiler)

Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4

Course of study, specific field and term:

- Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester
- Bachelor IT-Security 2016 (optional subject), computer science, Arbitrary semester
- Bachelor Computer Science 2014 (optional subject), central topics of computer science, 5th or 6th semester

Classes and lectures:

- Compiler Construction (lecture, 2 SWS)
- Compiler Construction (exercise, 1 SWS)

Workload:

- 60 Hours private studies and exercises
- 45 Hours in-classroom work
- 15 Hours exam preparation

Contents of teaching:

- phases of translation and their interfaces
- lexical analysis
- syntactic analysis
- semantic analysis
- abstract machines
- translating expressions and statements
- storage management
- block structure and procedures
- translating object-oriented language elements
- code generration and optimization

Qualification-goals/Competencies:

- The students can illustrate the basic concepts and methods of compiler construction.
- They can explain the functional principles of the different phases of a compiler.
- They can apply tools for compiler construction.
- They can compare problem-oriented and machine-oriented languages.
- They can transfer methods of compiler construction for solving related tasks.

Grading through:

- Written or oral exam as announced by the examiner

Requires:

- Theoretical Computer Science (CS2000-KP08, CS2000)

Responsible for this module:

- Prof. Dr. Martin Leucker

Teacher:

- Institute for Theoretical Computer Science
- Institute of Software Technology and Programming Languages
- Prof. Dr. Martin Leucker

Literature:

- A.V. Aho, M.S. Lam, R. Sethi, J. Ullman: Compilers: Principles, Techniques, and Tools - Pearson Education 2013
- R. Wilhelm, H. Seidl, S. Hack: Übersetzerbau (4 Bände) - Springer, eXamen.press

Language:

- German and English skills required

Notes:

Admission requirements for taking the module:
- None (the competencies of the modules listed under

CS3310-KP04 - Medical Image Computing (MBV4)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Bachelor Robotics and Autonomous Systems 2016 (optional subject), medical computer science, 5th or 6th semester

Classes and lectures:

- Medical Image Computing (lecture, 2 SWS)
- Medical Image Computing (exercise, 2 SWS)

Workload:

- 60 Hours in-classroom work
- 40 Hours private studies
- 20 Hours exam preparation

Contents of teaching:

- Motivation, principles and applications of medical image computing
- Structure and formats of medical images
- Histograms and image transformations
- Image filtering using Fourier transform
- Image filtering with local operators
- Segmentation: thresholding, region growing
- Clusteranalysis and classifyer for image segmentation
- Introducing convolutional neural networks
- Morphological operators
- Application and evaluation of segmentation methods
- Image interpolation methods and transformataion of images
- Basic methods of image registration
- Combined signal and image analysis in 4D image processing

Qualification-goals/Competencies:

- Students are able to classify basic medical image processing methods, are able to characterize them and to apply them to concrete problems.
- They are able to select appropriate, problem-specific methods for image filtering, image segmentation, and morphological post-processing of segmentation results, to combine them in a processing pipeline and to use them for image enhancement or image segmentation of medical structures.
- They are able to distinguish between different methods of cluster analysis and statistical and neural pattern recognition and can characterize them based on different implicitly used model assumptions and properties.
- They are able to evaluate segmentation results of different methods based on established quality measures and to carry out an objective comparison of the quality of different segmentation methods in practical use.
- They are able to distinguish between different image interpolation methods, to classify them according to their specific advantages and disadvantages and to select an appropriate method and apply it, depending on a specific problem.
- They are able to assess the characteristics of different rigid image registration methods. For a specific registration problem they are able to select problem specific similarity measures and regularization terms and to parameterize them.
- They are able to distinguish and to characterize different techniques for analyzing functional 4D fMRI image sequences, with whom neurally activated brain areas in 4D image sequences of the head can be made visible.
- They are able to implement basic image processing algorithms and to bring them to use in combination with medical image processing modules available from program libraries.

Grading through:

- written exam

Is requisite for:

- Model and AI-based image processing in medicine (CS4332-KP06)
- Advanced Techniques of Medical Image Processing (CS4370-KP04, CS4370)
- Image Analysis and Visualization in Diagnostics and Therapy (CS4330-KP08, CS4330SJ14)

Requires:

- Analysis 2 (MA2500-KP04, MA2500)
- Analysis 1 (MA2000-KP08, MA2000)

- Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500)
- Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000)
- Introduction to Medical Informatics (CS1300-KP04, CS1300)

Responsible for this module:

- Prof. Dr. rer. nat. habil. Heinz Handels

Teacher:

- Institute of Medical Informatics

- Prof. Dr. rer. nat. habil. Heinz Handels
- Dr. rer. nat. Jan Ehrhardt

Literature:

- H. Handels: Medizinische Bildverarbeitung - Stuttgart: Vieweg & Teubner 2009
- T. Lehmann: Handbuch der Medizinischen Informatik - München: Hanser 2004
- M. Sonka, V. Hlavac, R. Boyle: Image Processing, Analysis and Machine Vision - 2nd edition. Pacific Grove: PWS Publishing 1998

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None (the competences of the modules mentioned under "requires" are needed for this module, but are not a formal prerequisite).

Admission requirements for participation in module examination(s):
- Successful completion of exercise assignments as specified at the beginning of the semester.

Module Exam(s):
- CS3310-L1: Medical Image Processing, written exam, 60min, 100% of the module grade.

CS3420-KP04, CS3420 - Cryptology (Krypto14)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Master CLS 2023 (optional subject), computer science, 3rd semester
- Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Media Informatics 2020 (optional subject), computer science, 4th or 6th semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 5th or 6th semester
- Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester
- Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester
- Master CLS 2016 (optional subject), computer science, 3rd semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester
- Bachelor IT-Security 2016 (compulsory), IT-Security, 3rd semester
- Bachelor Medical Informatics 2014 (optional subject), computer science, 5th or 6th semester
- Bachelor Computer Science 2014 (optional subject), central topics of computer science, 5th or 6th semester

Classes and lectures:

- Cryptology (lecture, 2 SWS)
- Cryptology (exercise, 1 SWS)

Workload:

- 65 Hours private studies and exercises
- 45 Hours in-classroom work
- 10 Hours exam preparation

Contents of teaching:

- history of cryptography, classical systems
- mathematical and algorithmic basics
- design principles for cryptographic applications
- symmetric crypto systems
- public key crypto systems, digital signatures
- efficient implementation of crypto systems
- methods in cryptoanalysis
- cryptographic protocols

Qualification-goals/Competencies:

- The students are able to model and analyze IT security.
- They know basic cryptographic primitives and protocols.
- They can recognize cryptographic weakness.
- They can apply standard techniques in cryptology.
- They can explain and assess the historical and social significance of encrypting information.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. Maciej Liskiewicz

Teacher:

- Institute for Theoretical Computer Science
- Prof. Dr. Maciej Liskiewicz

Literature:

- J von zur Gathen: CryptoSchool - Springer 2015
- A. Beutelspacher, H. Neumann, T. Schwarzpaul: Kryptopgrafie in Theorie und Praxis - Vieweg 2005
- D. Wätjen: Kryptographie - Springer 2018
- J. Katz, Y. Lindell: Introduction to Modern Cryptography - Chapman & Hall, 2008
- C. Bauer: Secret History - The Story of Cryptology - CRC Press 2013
- B. Schneier: Applied Cryptography - J. Wiley 1996

Language:

- English, except in case of only German-speaking participants

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of exercise sheets as specified at the beginning of the semester

Module exam(s):
- CS3420-L1: Cryptology, written exam, 90 minutes, 100% of module grade

CS4172-KP04, CS4172 - Dependability of Computing Systems (ZuverlRSys)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 5th or 6th semester
- Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester
- Bachelor IT-Security 2016 (compulsory), IT-Security, 6th semester
- Bachelor Computer Science 2014 (optional subject), central topics of computer science, 6th semester
- Bachelor Computer Science 2014 (compulsory), specialization field IT security and safety, 6th semester
- Bachelor Computer Science 2012 (compulsory), specialization field IT security and safety, 6th semester
- Master Computer Science 2012 (optional subject), advanced curriculum security, 2nd or 3rd semester
- Master Computer Science 2012 (optional subject), specialization field software systems engineering, 3rd semester
- Master Computer Science 2012 (optional subject), advanced curriculum parallel and distributed system architecutres, 2nd or 3rd semester
- Master Computer Science 2012 (optional subject), specialization field robotics and automation, 3rd semester

Classes and lectures:

- Dependability of Computing Systems (lecture, 2 SWS)
- Dependability of Computing Systems (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Basic terms
- General redundancy techniques
- Fault diagnosis
- Reconfiguration and recovery
- Fault masking
- Examples for fault-tolerant systems

Qualification-goals/Competencies:

- The students are able to present the most important fault types in hardware and software and their abstraction to fault models.
- They are able to elucidate the basic redundancy techniques (static and dynamic redundancy, hybrid forms etc.).
- They are able to explain various methods for fault diagnosis, reconfiguration, recovery and fault masking.
- They are able to describe typical application examples and sample fault-tolerant computers.
- They are able to analyze fault tolerance techniques quantitatively by mathematical reliability models.
- They are able to valuate and compare suitable fault tolerance techniques and to select them for a given application area.

Grading through:

- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr.-Ing. Mladen Berekovic

Teacher:

- Institute of Computer Engineering
- Prof. Dr.-Ing. Mladen Berekovic

Literature:

- E. Dubrova: Fault-Tolerant Design - Springer 2013
- K. Echtle: Fehlertoleranzverfahren - Springer 1990
- I. Koren, C. M. Krishna: Fault Tolerant Systems - Morgan-Kaufman 2007
- K. Trivedi: Probability and Statistics with Reliability, Queuing, and Computer Science Applications - Wiley 2001

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of exercise assignments as specified at the beginning of the semester

Module Exam(s):
- CS4172-L1: Dependability of Computing Systems, written exam, 90min, 100% of the module grade

MA3110-KP04, MA3110 - Numerics 1 (Num1KP04)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Master Auditory Technology 2022 (optional subject), Elective, Arbitrary semester
- Bachelor Computer Science 2019 (optional subject), Extended optional subjects, Arbitrary semester
- Bachelor MES 2020 (optional subject), mathematics / natural sciences, 3rd semester at the earliest
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), mathematics, 5th or 6th semester
- Bachelor Medical Informatics 2019 (optional subject), mathematics, 4th to 6th semester
- Bachelor IT-Security 2016 (optional subject), mathematics, Arbitrary semester
- Master Auditory Technology 2017 (optional subject), compulsory module depending on previous knowledge , 1st semester
- Bachelor Computer Science 2016 (optional subject), advanced curriculum, Arbitrary semester
- Bachelor Computer Science 2016 (optional subject), Canonical Specialization Web and Data Science, 3rd semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), mathematics, 5th or 6th semester
- Bachelor Medical Informatics 2014 (optional subject), mathematics, 5th or 6th semester
- Bachelor MES 2014 (optional subject), mathematics / natural sciences, 3rd or 5th semester
- Bachelor Computer Science 2014 (optional subject), central topics of computer science, 5th semester
- Master MES 2011 (optional subject), mathematics, 1st semester
- Bachelor MES 2011 (optional subject), mathematics, 3rd semester
- Bachelor Computer Science 2012 (optional subject), mathematics, 5th or 6th semester

Classes and lectures:

- Numerics 1 (lecture, 2 SWS)
- Numerics 1 (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Round-off errors and condition
- Direct solvers for linear equations
- LR decomposition
- Perturbation theory
- Cholesky decomposition
- QR decomposition, least squares fit

Qualification-goals/Competencies:

- Students understand basic numerical tasks.
- They are proficient in the modern programming language MATLAB.
- They can implement theoretical algorithms.
- They can assess the quality of a method (accuracy, stability, complexity).

Grading through:

- written exam

Requires:

- Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500)
- Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000)
- Analysis 2 (MA2500-KP04, MA2500)
- Analysis 1 (MA2000-KP08, MA2000)

Responsible for this module:

- Prof. Dr. rer. nat. Andreas Rößler

Teacher:

- Institute for Mathematics
- Prof. Dr. rer. nat. Andreas Rößler

Literature:

- M. Bollhöfer, V. Mehrmann: Numerische Mathematik - Vieweg (2004)
- P. Deuflhard, A. Hohmann: Numerische Mathematik I - 4. Auflage, De Gruyter (2008)
- P. Deuflhard, F. Bornemann: Numerische Mathematik II - 3. Auflage, De Gruyter (2008)
- M. Hanke-Bourgeois: Grundlagen der Numerischen Mathematik und des Wissenschaftlichen Rechnens - 3. Aufl., Teubner (2009)
- H. R. Schwarz, N. Köckler: Numerische Mathematik - 6. Auflage, Teubner (2006)
- J. Stoer: Numerische Mathematik I - 10. Auflage, Springer (2007)
- J. Stoer, R. Bulirsch: Numerische Mathematik II - 5. Auflage, Springer (2005)
- A. M. Quarteroni, R. Sacco, F. Salieri: Numerical Mathematics - 2. Auflage, Springer (2006)

Language:

- offered only in German

Notes:

The lecture is identical to that in module MA3110-MML/Numerics 1.

Prerequisites for attending the module:
- None (The competences of the required modules are required for this module, but the modules are not a prerequisite for admission).

Prerequisites for the exam:
- Preliminary examinations can be determined at the beginning of the semester. If preliminary work has been defined, it must have been completed and positively assessed before the initial examination.

MA3445-KP04, MA3445 - Graph Theory (Graphen)

Duration:	Turnus of offer:	Credit points:
1 Semester	every second year	4

Course of study, specific field and term:

- Master MES 2020 (optional subject), mathematics / natural sciences, Arbitrary semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), mathematics, 5th or 6th semester
- Bachelor Medical Informatics 2019 (optional subject), mathematics, 4th to 6th semester
- Bachelor IT-Security 2016 (optional subject), mathematics, Arbitrary semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), mathematics, 5th or 6th semester
- Bachelor Medical Informatics 2014 (optional subject), mathematics, 5th or 6th semester
- Master MES 2014 (optional subject), mathematics / natural sciences, 1st or 2nd semester
- Bachelor Computer Science 2014 (optional subject), central topics of computer science, 5th or 6th semester
- Master CLS 2010 (optional subject), mathematics, Arbitrary semester
- Master MES 2011 (optional subject), mathematics, 1st or 2nd semester
- Bachelor CLS 2010 (optional subject), mathematics, 5th or 6th semester
- Bachelor Computer Science 2012 (optional subject), mathematics, 5th or 6th semester

Classes and lectures:

- Graph theory (lecture, 2 SWS)
- Graph theory (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Hamiltonian graphs and degree sequences
- Menger's theorem - new proofs
- Matchings and decompositions of graphs
- The theorems of Turan and Ramsey
- Vertex and edge colourings
- The four colour theorem

Qualification-goals/Competencies:

- Ability to solve discrete problems using graph theoretical methods
- Knowledge of proof techniques and ideas of discrete mathematics
- Knowledge of fundamental and selected recent research results

Grading through:

- Oral examination

Requires:

- Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500)
- Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000)

Responsible for this module:

- PD Dr. rer. nat. Christian Bey

Teacher:

- Institute for Mathematics
- PD Dr. rer. nat. Christian Bey

Literature:

- F. Harary: Graph Theory - Reading, MA:.Addison-Wesley 1969
- R. Diestel: Graphentheorie - Berlin: Springer 2000
- D. Jungnickel: Graphen, Netzwerke und Algorithmen - Mannheim: BI-Wissenschaftsverlag1994
- J. Bang-Jensen, G. Gutin: Digraphs: Theory, Algorithms and Applications - London: Springer 2001
- B. Bollobas: Modern Graph Theory - Berlin: Springer 1998

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None (the competencies of the modules listed under "Requires" are required for this module, but are not a formal prerequisite).

Admission requirements for taking module examination(s):
- Successful completion of exercises as specified at the beginning of the semester.

Module Exam(s):
- MA3445-L1: Graph Theory, oral exam, 30 min, 100% of module grade.

ME2152-KP01, ME2152 - Lecture series Industrial Medical Engineering (EMedTec2a)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	1

Course of study, specific field and term:

- Bachelor Robotics and Autonomous Systems 2016 (optional subject), medical engineering science, 5th or 6th semester

Classes and lectures:

- Lecture series History of Medical Engineering (lecture, 1 SWS)
- Lecture series Industrial Medical Technology (lecture, 0,5 SWS)

Workload:

- 15 Hours in-classroom work
- 15 Hours written report

Contents of teaching:

- History and philosophy of technology in general
- Theories of technolution (how and when do innovations emerge?)
- Critique and assessment of technology, technology assessment
- Fields of medical engineering and their historical development

Qualification-goals/Competencies:

- Students are able to describe and explain basic concepts, theories, and methods of history of technology studies.
- They can depict pivotal stages and controversies in the historical development of technology and medical engineering.
- They have an understanding of the philosophical and cultural implications of the production and application of technology, and are able to apply this knowledge to case studies.
- They are capable to identify questions of social acceptability of technology, to carve out their different implications, and to discuss them critically.
- They master to research, interpret, and analyze critically scientific literature on the module's topics.
- They have the communication competency to analyze and present societal aspects of technological issues in written form.

Grading through:

- continuous, successful participation in course

Responsible for this module:

- Prof. Dr. rer. nat. Thorsten Buzug

Teacher:

- Institute for History of Medicine and Science Studies
- Institute of Medical Engineering

- Prof. Dr. rer. nat. Thorsten Buzug
- Prof. Dr. med. Cornelius Borck
- Prof. Dr. rer. nat. Burghard Weiss

Literature:

- Orland B (Hrsg): Artifizielle Körper - lebendige Technik: Technische Modellierungen des Körpers in historischer Perspektive - Zürich: Chronos 2005
- Horx M: Frankfurt: Campus 2008 - Frankfurt: Campus 2008
- Kramme R (Hrsg.): Medizintechnik: Verfahren Systeme Informationsverarbeitung - Medizintechnik: Verfahren Systeme Informationsverarbeitung

Language:

- German and English skills required

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Regular and successful participation

ME2153-KP01, ME2153 - Introduction to scientific programming (EMedTec3a)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	1

Course of study, specific field and term:

- Bachelor Robotics and Autonomous Systems 2016 (optional subject), medical engineering science, 5th or 6th semester

Classes and lectures:

- ME2153-P: Introduction to scientific programming (practical course, 1 SWS)

Workload:

- 15 Hours private studies
- 15 Hours in-classroom work

Contents of teaching:

- Basics of scientific programming
- Basics of digital signal processing
- Basics of signal analysis and evaluation
- Image processing (local image operators, filtering in frequency space)
- Scientific visualization

Qualification-goals/Competencies:

- Students will be able to analyze syntax of a scientific programming language.
- Students will be able to use the help and documentation of scientific programming languages.
- Students can implement basic structures (e.g. loops and conditions).
- Students will be able to create matrices of any dimension and locate values within the matrices.
- Students will be able to apply and visualize signal filtering.
- Students will be able to demonstrate medically relevant visualization issues using external libraries.

Grading through:

- tasks for internship

Responsible for this module:

- Prof. Dr. rer. nat. Thorsten Buzug

Teacher:

- Institute of Medical Engineering
- Dr.-Ing. Ksenija Gräfe

Literature:

- Julia Tutorial (1):
- Julia Tutorial (2):
- Think Julia: How to Think Like a Computer Scientist (benlauwens.github.io):

Language:

- German and English skills required

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- 50% of the tasks must be completed correctly, one failed attempt is permitted

Module examination(s):
- ME2153-L1: Introduction to scientific programming, practical course, 0 % of the module grade, must be passed

ME3100-KP04, ME3100SJ14 - Medical Imaging (MBG14)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Bachelor Robotics and Autonomous Systems 2020 (optional subject), Additionally recognized elective module, 5th semester
- Master Auditory Technology 2022 (optional subject), Auditory Technology, 1st semester
- Master Auditory Technology 2017 (optional subject), Auditory Technology, 1st semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), medical image processing, 5th or 6th semester
- Bachelor Medical Informatics 2019 (optional subject), medical computer science, 4th to 6th semester
- Bachelor Medical Informatics 2014 (optional subject), medical computer science, 5th or 6th semester

Classes and lectures:

- Medical Imaging (lecture, 2 SWS)
- Medical Imaging (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Introduction to the theory of imaging systems
- Ultrasound imaging
- Conventional X-ray imaging, Computed Tomography
- Magnetic Resonance Imaging

Qualification-goals/Competencies:

- The students can characterise linear translation-invariant imaging systems by means of impulse response and transfer function.
- They can explain the Nyquist-Shannon theorem and justify its validity.
- They can describe what is meant by spatial resolution of an imaging system.
- They can give an overview of important medical imaging techniques.
- They can explain the physical foundations of ultrasound imaging.
- They can describe the behaviour of ultrasound waves at tissue borders.
- They can reason the fundamental limit to spatial resolution in US.
- They can list the interdependence between ultrasound frequency, spatial resolution, and penetration depth.
- They can elucidate how technical parameters are chosen for a given target to be imaged.
- They can discuss aim and realisation of beam forming in US imaging.
- They can explain how Doppler US works.
- They can describe why important US image artefacts occur.
- They can explain the physical and technical foundations of X-ray generation.
- They can sketch the typical spectrum of a technical X-ray source.
- They can list and describe the most important interaction processes between X-rays and matter.
- They can mention possible sources of hazard in X-ray imaging and discuss strategies for avoiding them.
- They can describe the influence of technical parameters in X-ray imaging systems.
- They can describe and justify important reconstruction principles in CT and their mathematical foundations.
- They can explain the physical foundations of nuclear magnetic resonance (NMR).
- They can describe how spatial resolution is achieved in NMR imaging.
- They can justify the occurrence of different types of radio frequency echoes in NMR.
- They can explain the concept of k-space.
- They can describe how different weightings are achieved in MR images.
- They can list sources of hazard in MRI and explain their causes.
- They can describe the technical components of an MR imaging system.
- They can implement important algorithms used in imaging systems.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Martin Koch

Teacher:

- Institute of Medical Engineering
- Prof. Dr. rer. nat. Martin Koch

Literature:

- O. Dössel: Bildgebende Verfahren in der Medizin - Springer, Berlin 2000
- H. Morneburg (Hrsg.): Bildgebende Systeme für die medizinische Diagnostik. 3. Aufl. - Publicis MCD Verlag, München 1995

Language:

- German and English skills required

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of exercise assignments as specified at the beginning of the semester.

Module Exam(s):
- ME3100-L1: Medical Imaging, written exam, 60min, 100% of the module grade.

ME3400-KP04, ME3400 - Medical Electrical Engineering Lab Course (METechPrak)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4 (Typ B)

Course of study, specific field and term:

- Bachelor MES 2020 (compulsory), electrical engineering, 5th semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), electrical engineering, 5th or 6th semester
- Bachelor MES 2014 (compulsory), electrical engineering, 5th semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), Additionally recognized elective module, 5th or 6th semester

Classes and lectures:

- Medical Electrical Engineering Lab Course (practical course, 3 SWS)

Workload:

- 65 Hours work on project
- 45 Hours in-classroom work
- 10 Hours oral presentation and discussion (including preparation)

Contents of teaching:

- Basics of electrical safety with focus on medical devices.
- Safety in the lab.
- Development, planning, creation and testing of an electrical circuit in the context of medical devices.
- Independent realization of a concrete project in a small team.

Qualification-goals/Competencies:

- Students can plan, design, specify and realize an electrical circuit.
- Students gain experience in the area of project management.
- Students know how to deliver and present results in a timely manner.

Grading through:

- presentation

Requires:

- Fundamentals of Electrical Engineering 2 (ME2700-KP08, ME2700)
- Fundamentals of Electrical Engineering 1 (ME2400-KP08, ME2400)

Responsible for this module:

- Prof. Dr. Philipp Rostalski

Teacher:

- Institute for Electrical Engineering in Medicine
- Prof. Dr. Philipp Rostalski

Literature:

- U. Tietze, C. Schenk, E. Gamm: Halbleiter-Schaltungstechnik - ISBN 978-3-642-31025-6

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- Fundamentals of Electrical Engineering 1 and 2 (ME2400 and ME2700)

Admission requirements for participation in module examination(s):
- Successful completion of the practical assignment and presentation.

Module Exam(s):
- ME3400-L1: Medical Electrical Engineering Lab Course, completion of internship assignment and presentation, 100% of module grade.

PS5830-KP04, PS5830 - Start-up and New Business (StartUp)

Duration:	Turnus of offer:	Credit points:
1 Semester	not available anymore	4 (Typ B)

Course of study, specific field and term:

- Master Media Informatics 2014 (optional subject), Interdisciplinary modules, Arbitrary semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), interdisciplinary competence, 5th or 6th semester
- Master Medical Informatics 2014 (optional subject), interdisciplinary competence, 1st or 2nd semester
- Master MES 2014 (optional subject), no specific field, 1st or 2nd semester
- Bachelor MES 2014 (optional subject), no specific field, Arbitrary semester
- Master Computer Science 2014 (optional subject), interdisciplinary competence, Arbitrary semester
- Bachelor MES 2011 (optional subject), interdisciplinary competence, Arbitrary semester
- Bachelor Computer Science 2014 (optional subject), central topics of computer science, 5th or 6th semester
- Master CLS 2010 (optional suject), interdisciplinary competence, 2nd or 3rd semester
- Master Computer Science 2012 (optional subject), interdisciplinary competence, 2nd or 3rd semester

Classes and lectures:

- Start-up and New Business (seminar, 1 SWS)
- Start-up and New Business (practical course, 1 SWS)

Workload:

- 45 Hours private studies
- 30 Hours in-classroom work
- 30 Hours written report
- 15 Hours oral presentation (including preparation)

Contents of teaching:

- Entre-/ Intrapreneurship
- Business Modelling
- Technology product, value propositions, and customer benefit
- Target groups, customer segments, and customer relations
- Sales channels, marketing and sources of income
- Key ressources / activities / partners
- costs and financing, including funding programs
- special subjects: quality, acceptance for trading, legal form of organization, a.o.

Qualification-goals/Competencies:

- The students have gained basic insights in the field of Start-up, new product development and new business development.
- They have acquired a sound knowledge of business modelling and planing.
- They are able to develop a business plan based on a particular project.
- They are able to assess the chances and risks of a start-up and new product / new business development.

Grading through:

- contributions to the discussion

Responsible for this module:

- Prof. Dr. Martin Leucker

Teacher:

- Institute of Software Technology and Programming Languages
- Dr. Raimund Mildner

Literature:

- Aktuelle Forschungsartikel werden in der Veranstaltung bekanntgegeben.:

Language:

- offered only in German

RO5300-KP06 - Humanoid Robotics (HumRob)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	6

Course of study, specific field and term:

- Master Biophysics 2019 (optional subject), Elective, 1st or 2nd semester
- Bachelor Media Informatics 2020 (optional subject), Robotics and Autonomous Systems, 5th or 6th semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), Robotics and Autonomous Systems, 5th or 6th semester
- Bachelor Medical Informatics 2019 (optional subject), medical computer science, 4th to 6th semester
- Bachelor Medical Informatics 2014 (optional subject), Robotics and Autonomous Systems, 5th or 6th semester
- Bachelor Media Informatics 2014 (optional subject), Robotics and Autonomous Systems, 5th or 6th semester
- Bachelor IT-Security 2016 (optional subject), Robotics and Autonomous Systems, Arbitrary semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), Robotics and Autonomous Systems, 5th or 6th semester

Classes and lectures:

- Humanoid Robotics (lecture, 2 SWS)
- Humanoid Robotics (exercise, 2 SWS)

Workload:

- 100 Hours private studies
- 60 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Development of humanoid robots: The special features of the kinematics of humanoid robots based on the human model are considered. Challenges and strategies for the design of humanoid robots are discussed. Mechatronic concepts for humanoid robot development are presented using examples.
- Control of humanoid walking robots: Basic concepts for the planning and control of walking movements are introduced. The characteristics of human locomotion are considered. Based on this, the motion planning and control of robotic walking is presented.
- Gripping with humanoid robot hands: Grip planning and grip synthesis with humanoid robot hands is presented. Basic characteristics of human grasping are considered. Analytical methods for planning and evaluating grasps are discussed and modern approaches for learning grasps are introduced.
- Modeling and planning: Basic concepts of modeling and planning tasks are discussed. The description of a goal-oriented action using modular actions is shown. Optimization methods for automated action planning are presented.

Qualification-goals/Competencies:

- Students acquire the ability to independently solve application-oriented exercises from robotics, with a focus on (humanoid) robots with a mathematical background
- You have a basic understanding of the kinematic properties of humanoid robots
- They know the requirements for the design of humanoid robots and understand mechatronic concepts for the development of human-inspired robot kinematics.
- They understand the complexity of controlling humanoid robots, especially with regard to bipedal walking and gripping with five-fingered hands, including the dynamic processes
- You have gained an insight into learning methods for planning the action sequences of humanoid robots, including the dynamic processes
- You have experience in programming humanoid robots

Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr.-Ing. Julia Starke

Teacher:

- Institute for Robotics and Cognitive Systems
- Prof. Dr.-Ing. Julia Starke

Literature:

- Murray, Li and Sastry: A mathematical introduction to robotic manipulation - CRC Press 1994

Language:

-

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of exercise assignments as specified at the beginning of the semester

Module Exam(s):
- RO5300-L1: Humanoid Robotics, oral exam, 100% of the module grade

RO5401 - Seminar Robotics and Navigation (SemRobNav)

Duration:	Turnus of offer:	Credit points:
1 Semester	each semester	4 (Typ B)

Course of study, specific field and term:

- Bachelor Robotics and Autonomous Systems 2020 (optional subject), Robotics and Autonomous Systems, 5th or 6th semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), Robotics and Autonomous Systems, 5th or 6th semester

Classes and lectures:

- Seminar Robotics and Navigation (seminar, 2 SWS)

Workload:

- 90 Hours work on an individual topic with written and oral presentation
- 30 Hours in-classroom work

Contents of teaching:

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Qualification-goals/Competencies:

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Grading through:

- presentation

Responsible for this module:

- Prof. Dr.-Ing. Achim Schweikard

Teacher:

- Institute for Electrical Engineering in Medicine
- Institute for Robotics and Cognitive Systems
- Institute of Computer Engineering

- Prof. Dr.-Ing. Mladen Berekovic
- Prof. Dr.-Ing. Achim Schweikard
- Prof. Dr. Philipp Rostalski

Language:

- German and English skills required

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- None

Module Exam(s):
- RO5401-L1: Seminar Robotics and Navigation, Seminar, 100% of module grade.

CS3100-KP04 - Signal processing (SignalV)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Bachelor Robotics and Autonomous Systems 2016 (compulsory), computer science, 5th semester
- Bachelor Medical Informatics 2011 (compulsory), computer science, 5th semester
- Master CLS 2010 (compulsory), mathematics, 1st semester
- Bachelor Computer Science 2012 (compulsory), foundations of computer science, 5th semester

Classes and lectures:

- Signal processing (lecture, 2 SWS)
- Signal processing (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Linear time-invariant systems
- Impulse response
- Convolution
- Fourier transform
- Transfer function
- Correlation and energy density of deterministic signals
- Sampling
- Discrete-time signals and systems
- Discrete-time Fourier transform
- z-Transform
- FIR and IIR filters
- Block diagrams
- FIR filter design
- Discrete Fourier transform (DFT)
- Fast Fourier transform (FFT)
- Characterization and processing of random signals

Qualification-goals/Competencies:

- Students are able to explain the fundamentals of linear system theory.
- They are able to describe the basic elements of signal processing.
- They will have a command of methods for the description and analysis of continuous-time and discrete-time signals and systems.
- They are able to design digital filters and know various structures for their implementation.
- They are able to explain the basic techniques for describing and processing of random signals.

Grading through:

- Written or oral exam as announced by the examiner

Is requisite for:

- Image processing (CS3203)

Responsible for this module:

- Prof. Dr.-Ing. Alfred Mertins

Teacher:

- Institute for Signal Processing
- Prof. Dr.-Ing. Alfred Mertins

Literature:

- A. Mertins: Signaltheorie: Grundlagen der Signalbeschreibung, Filterbänke, Wavelets, Zeit-Frequenz-Analyse, Parameter- und Signalschätzung - Springer-Vieweg, 3. Auflage, 2013

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Successful completion of homework assignments during the semester (at least 50% of the max. points).

Modul exam:
- CS3100-L1: Signal Processing, written exam, 120 Min,. 100% of modul grade

CS3100-KP08, CS3100SJ14 - Signal Processing (SignalV14)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	8

Course of study, specific field and term:

- Master CLS 2023 (compulsory), mathematics, 1st semester
- Bachelor Biophysics 2024 (compulsory), computer science, 5th semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory), Robotics and Autonomous Systems, 5th semester
- Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Computer Science 2019 (compulsory), Canonical Specialization Bioinformatics and Systems Biology, 5th semester
- Bachelor MES 2020 (compulsory), computer science, 5th semester
- Bachelor Media Informatics 2020 (optional subject), computer science, 5th or 6th semester
- Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester
- Bachelor Computer Science 2014 (compulsory), specialization field robotics and automation, 5th semester
- Bachelor Computer Science 2014 (compulsory), specialization field bioinformatics, 5th semester
- Bachelor Computer Science 2016 (compulsory), Canonical Specialization Bioinformatics, 5th semester
- Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Computer Science 2016 (compulsory), Canonical Specialization Web and Data Science, 5th semester
- Master CLS 2016 (compulsory), mathematics, 1st semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 5th semester
- Bachelor IT-Security 2016 (optional subject), computer science, Arbitrary semester
- Bachelor Biophysics 2016 (compulsory), computer science, 5th semester
- Bachelor Medical Informatics 2014 (compulsory), computer science, 5th semester
- Bachelor MES 2014 (compulsory), computer science, 5th semester
- Bachelor Media Informatics 2014 (optional subject), computer science, 5th or 6th semester
- Bachelor Computer Science 2014 (optional subject), central topics of computer science, 5th semester

Classes and lectures:

- Signal Processing (lecture, 2 SWS)
- Signal Processing (exercise, 1 SWS)
- Image Processing (lecture, 2 SWS)
- Image Processing (exercise, 1 SWS)

Workload:

- 110 Hours private studies
- 90 Hours in-classroom work
- 40 Hours exam preparation

Contents of teaching:

- Linear time-invariant systems
- Impulse response
- Convolution
- Fourier transform
- Transfer function
- Correlation and energy density of deterministic signals
- Sampling
- Discrete-time signals and systems
- Discrete-time Fourier transform
- z-Transform
- FIR and IIR filters
- Block diagrams
- FIR filter design
- Discrete Fourier transform (DFT)
- Fast Fourier transform (FFT)
- Characterization and processing of random signals
- Introduction, interest of visual information
- 2D Sampling
- Image enhancement
- Edge detection
- Multiresolution concepts: Gaussian and Laplacian Pyramid, wavelets
- Principles of image compression
- Segmentation
- Morphological image processing

- Students work self-actingly and independently with regard to the roles of GSP of the University of Lübeck.

Qualification-goals/Competencies:

- Students are able to explain the fundamentals of linear system theory.
- They are able to define and competently explain the essential elements of signal processing mathematically.
- They will have a command of mathematical methods for the description and analysis of continuous-time and discrete-time signals and systems.
- They are able to design digital filters and know various structures for their implementation.
- They are able to explain the basic techniques for describing and processing of random signals.
- They will have basic knowledge of two-dimensional system theory.
- They are able to describe the main techniques for image analysis and image enhancement.
- They are able to apply the learned principles in practice.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr.-Ing. Alfred Mertins

Teacher:

- Institute for Signal Processing
- Prof. Dr.-Ing. Alfred Mertins

Literature:

- A. Mertins: Signaltheorie: Grundlagen der Signalbeschreibung, Filterbänke, Wavelets, Zeit-Frequenz-Analyse, Parameter- und Signalschätzung - Springer-Vieweg, 3. Auflage, 2013
- A. K. Jain: Fundamentals of Digital Image Processing - Prentice Hall, 1989
- Rafael C. Gonzalez, Richard E. Woods: Digital Image Processing - Prentice Hall 2003

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Successful completion of homework assignments during the semester (at least 50% of max. points).

Module exam:
- CS3100-L1: Signal Processing, written exam, 90 min, 100% of module grade

CS3501-KP04, CS3501 - Lab Course Robotics and Automation (PraktRob)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4 (Typ B)

Course of study, specific field and term:

- Bachelor Robotics and Autonomous Systems 2020 (compulsory), Robotics and Autonomous Systems, 5th semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 5th semester
- Bachelor Computer Science 2014 (compulsory), specialization field robotics and automation, 5th semester
- Bachelor Computer Science 2012 (compulsory), specialization field robotics and automation, 5th semester

Classes and lectures:

- Lab Class Robotics and Automation (practical course, 3 SWS)

Workload:

- 45 Hours in-classroom work
- 45 Hours group work
- 30 Hours private studies

Contents of teaching:

- Combination of robotics and navigation
- Introduction to project management
- Realization of different robotic tasks in virtual and real environment
- Kinematics (direct and inverse)
- Implementation in the environments using sensor technology
- Human-Robot-Interaction

Qualification-goals/Competencies:

- The students can realize different concepts of robot and navigation system control and of mobile robots in real life systems.
- They are able to implement the combination of robotics and navigation for simple tasks.
- The students are in a position to do the project planning and realize it in teamwork according to predefined milestones.

Grading through:

- programming project

Requires:

- Robotics (CS2500-KP04, CS2500)

Responsible for this module:

- Prof. Dr.-Ing. Achim Schweikard

Teacher:

- Institute for Electrical Engineering in Medicine
- Institute of Computer Engineering
- Institute for Robotics and Cognitive Systems

- Prof. Dr.-Ing. Achim Schweikard
- Prof. Dr.-Ing. Mladen Berekovic
- Prof. Dr. Philipp Rostalski
- Dr.-Ing. Kristian Ehlers

Literature:

- Jazar: Theory of applied Robotics: Kinematics, Dynamics and Control
- Hertzberg et.al.: Mobile Roboter - Springer 2012
- Siegert: Robotik: Programmierung intelligenter Roboter
- Siegwart et.al.: Autonomous Mobile Robots - MIT Press, 2011

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None (the competencies of the modules listed under

ME2151-KP04, ME2151 - Introduction to Medical Engineering (EMedTecMI)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4

Course of study, specific field and term:

- Bachelor Robotics and Autonomous Systems 2020 (optional subject), Robotics and Autonomous Systems, 5th or 6th semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 5th semester
- Bachelor Medical Informatics 2014 (compulsory), medical computer science, 3rd semester

Classes and lectures:

- Introduction to Medical Engineering (lecture, 2 SWS)
- Introduction to Medical Engineering (exercise, 1 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Fundamentals of medical measurement technology
- Methods of functional diagnostics
- Imaging systems
- Therapy systems
- Monitoring
- Medical informatics
- Important legal requirements
- Medical applications

Qualification-goals/Competencies:

- Students know how different signals in the body are formed and can be measured.
- They understand the complex mechanisms involved in the metrology of physiological parameters.
- Students are able to explain the physical phenomena of relevant biological processes and methods of measurement.
- The students are able to transfer basic problems and solutions within the medical industry.
- Students will be able to understand basic signal processing processes and implement them using a simulation environment.
- Students are able to assess the advantages and disadvantages, as well as the limitations of each method.
- Students are able to explain the applications of different medical measuring systems.
- Students will have an overview of the current state of medical technology.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Thorsten Buzug

Teacher:

- Institute of Medical Engineering
- Dr.-Ing. Ksenija Gräfe

Literature:

- R. Kramme (Hrsg.): Medizintechnik: Verfahren Systeme Informationsverarbeitung - Springer Verlag, 2011
- J. D. Enderle, J. D. Bronzino: Introduction to Biomedical Engineering - Elsevier, 2011

Language:

- German and English skills required

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Successful completion of exercise sheets as specified at the beginning of the semester

Module examination(s):
- ME2151-L1: Introduction to medical technology, written exam, 90 min, 100 % of the module grade

RO3100-KP07 - Bachelor Project Robotics and Autonomous Systems (BacProjRAS)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	7 (Typ B)

Course of study, specific field and term:

- Bachelor Robotics and Autonomous Systems 2020 (compulsory), Robotics and Autonomous Systems, 5th semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 5th semester

Classes and lectures:

- Bachelor Project Robotics and Autonomous Systems (practical course, 5 SWS)

Workload:

- 120 Hours group work
- 45 Hours in-classroom work
- 15 Hours written report
- 10 Hours oral presentation (including preparation)

Contents of teaching:

- Team-based planning and realization of a complete development project in the domain of robotics and autonomous systems ranging from requirement engineering to installation while observing standards and deadlines.

Qualification-goals/Competencies:

- In discussions with users, the students can gather the requirements for a system solution.
- They can analyse complex tasks, structure them into subtasks, and implement them in team work
- They can estimate the costs, plan the acitvities, and allocate the ressources meeting the goals of the project
- They can integrate components into an overall application while ensuring software quality
- They can manage created artefacts, document implementations and present results

Grading through:

- successful addressing of the project goals

Responsible for this module:

- Prof. Dr. Philipp Rostalski

Teacher:

- Institute of Computer Engineering
- Institute for Robotics and Cognitive Systems
- Institute for Electrical Engineering in Medicine

- Alle prüfungsberechtigten Dozentinnen/Dozenten des Studienganges

Literature:

- Udo Lindemann: Methodische Entwicklung technischer Produkte: Methoden flexibel und situationsgerecht anwenden (VDI-Buch) - Springer, 2009

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of the internship assignment
- Documentation and (possibly interim) presentation as specified when the internship is issued.

Module examination(s):
- RO3100-L1: Bachelor Project Robotics and Autonomous Systems, internship performance and documentation and presentation, 100% of module grade.

CS3050-KP04, CS3050 - Coding and Security (CodeSich)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Computer Science 2019 (compulsory), Canonical Specialization Web and Data Science, 2nd semester
- Bachelor Computer Science 2019 (optional subject), Canonical Specialization SSE, 2nd semester
- Bachelor Media Informatics 2020 (optional subject), computer science, 5th or 6th semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 6th semester
- Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester
- Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Computer Science 2016 (optional subject), Canonical Specialization Web and Data Science, 2nd semester
- Bachelor Computer Science 2016 (optional subject), Canonical Specialization SSE, 2nd semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 6th semester
- Bachelor IT-Security 2016 (compulsory), IT-Security, 4th semester
- Bachelor Medical Informatics 2014 (optional subject), computer science, 5th or 6th semester
- Bachelor Media Informatics 2014 (optional subject), computer science, 5th or 6th semester
- Master CLS 2010 (optional suject), computer science, Arbitrary semester

Classes and lectures:

- Coding and Security (lecture, 2 SWS)
- Coding and Security (exercise, 1 SWS)

Workload:

- 65 Hours private studies and exercises
- 45 Hours in-classroom work
- 10 Hours exam preparation

Contents of teaching:

- information, entropie
- discrete sources and channels
- coding systems, error-tolerant codes
- codes for digital media, compression
- threats to IT-systems
- formal definition of security properties
- security primitives

Qualification-goals/Competencies:

- The students can explain and apply the basics of information and coding theory
- They can explain the concept of information.
- They are able to model information sources and communication networks.
- They know the most important codes and are familiar with their specific design principles and properties.
- They know basic scenarios of attacks and protection methods.

Grading through:

- written exam

Requires:

- Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000)

Responsible for this module:

- Prof. Dr. Rüdiger Reischuk

Teacher:

- Institute for Theoretical Computer Science

- Prof. Dr. Rüdiger Reischuk
- Prof. Dr. Maciej Liskiewicz

Literature:

- D. Hoffmann: Einführung in die Informations- und Codierungstheorie - Springer Vieweg 2014

- D. Salomon: Coding for Data and Computer Communications - Springer 2005
- D. Salomon: Data Privacy and Security - Springer 2003
- M. Stamp: Information Security: Principles and Practice - Wiley 2006
- R. Roth: Introduction to Coding Theory - Cambridge Univ. Press 2006

Language:

- German and English skills required

Notes:

Admission requirements for taking the module:
- None (the competencies of the modules listed under

CS3204-KP04, CS3204 - Artificial Intelligence 1 (KI1)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Bachelor Biophysics 2024 (optional subject), computer science, 6th semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory), Robotics and Autonomous Systems, 6th semester
- Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester
- Bachelor MES 2020 (optional subject), computer science / electrical engineering, 3rd semester at the earliest
- Bachelor Media Informatics 2020 (optional subject), computer science, 5th or 6th semester
- Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester
- Bachelor MES 2014 (optional subject), computer science / electrical engineering, 3rd semester at the earliest
- Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester
- Bachelor Computer Science 2016 (compulsory), Canonical Specialization Web and Data Science, 6th semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 6th semester
- Bachelor IT-Security 2016 (optional subject), computer science, Arbitrary semester
- Bachelor Biophysics 2016 (optional subject), computer science, 6th semester
- Bachelor Medical Informatics 2014 (optional subject), computer science, 5th or 6th semester
- Bachelor Media Informatics 2014 (optional subject), computer science, 5th or 6th semester
- Bachelor Computer Science 2014 (optional subject), central topics of computer science, 6th semester
- Bachelor Computer Science 2014 (compulsory), specialization field robotics and automation, 6th semester
- Bachelor Medical Informatics 2011 (optional subject), Applied computer science, 4th to 6th semester
- Bachelor CLS 2010 (optional subject), computer science, 6th semester
- Bachelor MES 2011 (optional subject), medical engineering science, 6th semester
- Bachelor Computer Science 2012 (compulsory), specialization field robotics and automation, 4th semester
- Bachelor Computer Science 2012 (optional subject), central topics of computer science, 5th or 6th semester

Classes and lectures:

- Artificial Intelligence (lecture, 2 SWS)
- Artificial Intelligence (exercise, 2 SWS)

Workload:

- 55 Hours private studies
- 45 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Part 1: Search strategiesAs an introduction and a prerequisite for most of the principles of artificial intelligence search strategies are introduced and explained. We will introduce uninformed, informed, local search, adversial search as well as heuristic search. The concept of agents will be presented.
- Part 2: Learning and reasoningRevision of the foundations of mathematical logic and probability. Principles of machine learning (supervised and unsupervised) are introduced. An introduction to fuzzy logic is also included.
- Part 3: Applications of artificial intelligenceTypical applications in the fields or robotics, machine vision, and industrial image and data processing are identified. Ethical issues and risks of the development of artificial intelligence are discussed.

Qualification-goals/Competencies:

- The students are able to handle scope-oriented tutorials with a mathematical background in a team, and timely.
- They have developed an understanding for the benefits and disadvantages of the different search and problem solving techniques.
- The students are in a position to choose and apply independently appropriate algorithms for search and learning issues.
- They have gained an insight into the complex development of systems with artificial intelligence and the distinction of its various forms.
- The students have an understanding of the risks and possible technological consequences of the development of systems with strong AI.

Grading through:

- portfolio exam

Requires:

- Analysis 2 (MA2500-KP04, MA2500)
- Algorithms and Data Structures (CS1001-KP08, CS1001)

Responsible for this module:

- Prof. Dr. rer. nat. Floris Ernst

Teacher:

- Institute for Robotics and Cognitive Systems
- MitarbeiterInnen des Instituts
- Prof. Dr. rer. nat. Floris Ernst

Literature:

- G. Görz (Hrsg.): Handbuch der Künstlichen Intelligenz - München: Oldenbourg Wissenschaftsverlag, 2003
- C-M. Bishop: Pattern Recognition and Machine Learning - Springer Verlag, 2007
- Russell/Norvig: Artificial Intelligence: a modern approach - (3rd Ed.), Prentice Hall, 2009
- Mitchell: Machine Learning - McGraw-Hill, 1997
- Luger: Artificial Intelligence: Structures and Strategies for Complex Problem Solving - (6th Ed.), Addison-Wesley, 2008

Language:

- offered only in German

Notes:

Admission requirements for taking the module
- None (the competences of the modules mentioned under Requires are needed for this module, but are not a formal prerequisite).

Admission requirements for participation in module examination(s):
- Successful completion of exercises as specified at the beginning of the semester.

Moduel Exam(s):
- CS3204-L1: Artificial Intelligence, Portfolio examination, 100% of the module grade

Note: The portfolio examination consists of: 70 points in the form of a written examination at the end of the semester, 15 points in the form of semester-accompanying programming tasks (group and individual performance), 15 points in the form of semester-accompanying e-tests (individual performance)

ME3300-KP04, ME3300 - Measurement Technology (MTech)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4

Course of study, specific field and term:

- Bachelor MES 2020 (optional subject), computer science / electrical engineering, 3rd semester at the earliest
- Bachelor IT-Security 2016 (optional subject), mathematics, Arbitrary semester
- Bachelor Robotics and Autonomous Systems 2016 (optional subject), electrical engineering, 6th semester
- Bachelor MES 2014 (optional subject), computer science / electrical engineering, 4th or 6th semester
- Bachelor Robotics and Autonomous Systems 2020 (optional subject), Additionally recognized elective module, 6th semester

Classes and lectures:

- Measurement Technology (lecture, 2 SWS)
- Measurement Technology (exercise, 0,5 SWS)
- Measurement Technology (project work, 0,5 SWS)

Workload:

- 60 Hours work on project
- 30 Hours in-classroom work
- 20 Hours exam preparation
- 10 Hours oral presentation and discussion (including preparation)

Contents of teaching:

- Measuring systems and measuring errors
- Application areas of measurement technology: temperature sensors, displacement and velocity measurement, electrical potential measurement, biosignal measurement, capacitance measurement, impedance measurement, humidity measurement, concentration measurements
- Electrotechnical measuring circuits
- Non-ideal amplifiers and filter circuits
- Probability theory
- Measurement of stochastic signals
- Description of measured signals
- Acquisition of analog signals
- Practical measurement data acquisition
- Requirements of medical technology for measurement technology
- Observation of non-measurable conditions

Qualification-goals/Competencies:

- The students know the elements of the measurement chain in detail, how they can be characterized and their possible characteristics.
- The students are able to describe and evaluate requirements for measurement technology.
- They are able to design and characterize basic electrical measurement circuits.
- The students are familiar with essential measuring instruments and methods, especially with a focus on medical metrology and mechatronics.
- The students know the essential connections between measuring element and control loop.

Grading through:

- Written or oral exam as announced by the examiner

Requires:

- Fundamentals of Electrical Engineering 1 (ME2400-KP08, ME2400)

Responsible for this module:

- Prof. Dr. Georg Schildbach

Teacher:

- Institute for Electrical Engineering in Medicine
- Prof. Dr. Georg Schildbach

Literature:

- Lerch: Elektrische Messtechnik: Analoge, digitale und computergestützte Verfahren - 6. Auflage, Springer Verlag 2012
- Schrüfer, Reindl, Zagar: Elektrische Messtechnik: Messung elektrischer und nichtelektrischer Größen - 11. Auflage, Carl Hanser Verlag

2014

- Parthier: Messtechnik: Grundlagen und Anwendungen der elektrischen Messtechnik - 8. Auflage, Springer Vieweg Verlag 2016
- Webster: Medical Instrumentation: Application and Design - 4th edition, John Wiley & Sons 2010

Language:

- German and English skills required

Notes:

currently suspended

RO3990-KP15 - Bachelor Thesis Robotics and Autonomous Systems (BScRAS)

Duration:	Turnus of offer:	Credit points:
1 Semester	each semester	15

Course of study, specific field and term:

- Bachelor Robotics and Autonomous Systems 2020 (compulsory), Robotics and Autonomous Systems, 6th semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 6th semester

Classes and lectures:

- Bachelor Thesis Robotics and Autonomous Systems (supervised self studies, 1 SWS)
- Colloquium (presentation (incl. preparation), 1 SWS)

Workload:

- 360 Hours research for and write up of a thesis
- 90 Hours oral presentation and discussion (including preparation)

Contents of teaching:

- investigating a given problem in robotics and autonomous systems or application areas and developing a good solution
- colloquium to represent the results including a discussion with the referees

Qualification-goals/Competencies:

- Students are able to solve a limited task of a scientific problem with the means of their discipline.
- They have the expertise to plan, organize and carry out a project work.
- They can present complex information in written and oral form.
- They are experts for a clearly defined topic.

Grading through:

- Written report

Responsible for this module:

- Studiengangsleitung Robotik und Autonome Systeme

Teacher:

- Institutes of the Department of Computer Science/ Engineering
- Alle prüfungsberechtigten Dozentinnen/Dozenten des Studienganges

Literature:

- depends on subject:

Language:

- thesis can be written in German or English

Notes:

Admission requirements for taking the module:
- See study program regulations (e.g. certain minimum CP achieved).

Admission requirements for participation in module examination(s):
- see study program regulations

Module Exam(s):
- RO3990-L1: Bachelor Thesis Robotics and Autonomous Systems, final paper, 100% of module grade.

RO4400-KP08 - Control Systems (RegelSys)

Duration:	Turnus of offer:	Credit points:
1 Semester	every summer semester	8

Course of study, specific field and term:

- Master MES 2020 (optional subject), computer science / electrical engineering, Arbitrary semester
- Bachelor Robotics and Autonomous Systems 2020 (compulsory), Robotics and Autonomous Systems, 6th semester
- Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 6th semester

Classes and lectures:

- Control Systems (lecture, 2 SWS)
- Advanced Methods in Control (lecture, 2 SWS)
- Control Systems (exercise, 1 SWS)
- Advanced Methods in Control (exercise, 1 SWS)

Workload:

- 110 Hours private studies
- 90 Hours in-classroom work
- 40 Hours exam preparation

Contents of teaching:

- Modeling of dynamic systems
- Dynamic behavior of systems
- Feedback concepts
- Controller design in time domain
- System representation in frequency domain
- Stability
- Controller design in frequency domain
- State space models, canonical representations and properties
- Design of state feedback controllers and state observers
- Optimal control and state estimation
- Linear parameter-varying systems
- Model predictive control

Qualification-goals/Competencies:

- Students can model physical systems mathematically as well as describe and analyze their dynamic behavior.
- Students know the fundamental tools and can formulate requirements with respect to systems in the time and frequency domain. Students are able to design control loops using time and frequency domain-based tools.
- Students are able to analyze stability of feedback systems and can evaluate the resulting dynamic properties with respect to control performance and robustness.
- Students know how to describe and analyze state space models.
- Students know how to synthesize and design state feedback controllers.
- Students know how to design observers and observer-based controllers.
- Students know the basics about optimal control and how to utilize it.
- Students know the class of linear, parameter-varying systems and the basic principles of controller synthesis for this class of systems.
- Students understand the concept of model-predictive control and know how to implement such a control strategy.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. Philipp Rostalski

Teacher:

- Institute for Electrical Engineering in Medicine
- Prof. Dr. Philipp Rostalski
- Prof. Dr.-Ing. Christian Herzog

Literature:

- as described for the module parts:

Language:

- German and English skills required

Notes:

This module replaces ME2450-KP08

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- None

Module Exam(s):
- RO4400-L1: Control Systems, written exam, 90min, 100% of module grade.