UNIVERSITÄT ZU LÜBECK

Module Guide for the Study Path

Bachelor Medical Informatics 2011

Version from 1. October 2024

1st and 2nd semester

1st semester

2nd semester

3rd and 4th semester

3rd semester

4th semester

4th to 6th semester

5th semester

6th semester

MZ2150 - Introduction to Medicine (EMed_)

Duration:	Turnus of offer:	Credit points:
2 Semester	not available anymore	12

Course of study, specific field and term:

- Bachelor MES 2011 (compulsory), medical engineering science, 1st and 2nd semester
- Bachelor Medical Informatics 2011 (compulsory), medical computer science, 1st and 2nd semester

Classes and lectures:

- MZ2100 A: Anatomie (course, 2 SWS)
- MZ2100 B: Pathologie (course, 2 SWS)
- MZ2100 D: Physiologie (course, 2 SWS)
- MZ2100 E: Zellbiologie und Genetik (course, 2 SWS)

Workload:

- 180 Hours private studies
- 120 Hours in-classroom work
- 60 Hours exam preparation

Contents of teaching:

- See individual module parts

Grading through:

- written exam

Responsible for this module:

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

Teacher:

- Institute for Biology
- Institute of Neurobiology
- Department of Pathology
- Institute of Anatomy
- Prof. Dr. med. Hartmut Gehring

Language:

- offered only in German

CS1000 - Programming (Prog)

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

Course of study, specific field and term:

- Bachelor Medical Informatics 2011 (compulsory: aptitude test), computer science, 1st semester
- Bachelor MES 2011 (compulsory), foundations of computer science, 3rd semester
- Bachelor Computer Science 2012 (compulsory: aptitude test), computer science, 1st semester

Classes and lectures:

- Programming (lecture, 4 SWS)
- Programming (exercise, 2 SWS)

Workload:

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

Contents of teaching:

- Definition: Algorithm
- Basic concepts of imperative and OO programming
- Basic data structures
- Abstract Data types

Qualification-goals/Competencies:

- Understanding the nature of algorithms and their definition
- Basic knowledge about different programming paradigms (imperative, declarative, object-oriented, etc.)
- Profound knowledge about imperative and object-oriented programming
- Ability to define abstract data types
- In-depth knowledge of the Java programming language
- Ability to design, to implement, and to test simple programs
- Expertise to solve bigger programming tasks efficiently and timely using the acquired competences
- Learn to come up with solutions that satisfy accepted quality standards while operating with constrained resources in terms of time, man-power, etc.
- Ability to introduce new informatic or mathematical methods to products to be developed or existing solutions
- Basic understanding of product development in enterprises

Grading through:

- written exam

Is requisite for:

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

Responsible for this module:

- Prof. Dr. Stefan Fischer

Teacher:

- Institute of Telematics
- Prof. Dr. Stefan Fischer

Literature:

- M. Broy: Informatik - eine grundlegende Einführung (Band 1 und 2) - Springer-Verlag 1998
- G. Goos und W. Zimmermann: Vorlesungen über Informatik (Band 1 und 2) - Springer-Verlag, 2006
- D. J. Barnes und M. Kölling: Objektorientierte Programmierung mit Java - Pearson Studium, 2003
- T. Stark und G. Krüger: Handbuch der Java-Programmierung - 5. Auflage, Addison-Wesley, 2007
- Robert Sedgewick und Kevin Wayne: Einführung in die Programmierung mit Java - Pearson Studium (ISBN-13: 978-3868940763)

Language:

- offered only in German

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

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

MZ2100 A - Module Part: Course Anatomy (Anatomie)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	3

Course of study, specific field and term:

- Bachelor MES 2020 (Module part of a compulsory module), medicine, 1st semester
- Bachelor Medical Informatics 2019 (Module part of a compulsory module), medical computer science, 1st semester
- Bachelor MES 2014 (Module part of a compulsory module), medicine, 1st semester
- Bachelor Medical Informatics 2014 (Module part of a compulsory module), medical computer science, 1st semester
- Bachelor Medical Informatics 2011 (Module part of a compulsory module), medical computer science, 1st semester
- Bachelor MES 2011 (Module part of a compulsory module), medicine, 1st semester
- Bachelor Computer Science 2012 (Module part of a compulsory module), specialization field medical informatics, 3rd semester

Classes and lectures:

- Anatomy (lecture, 2 SWS)

Workload:

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

Contents of teaching:

- Cytology
- Microscopic anatomy
- Anatomical regions of the human body using medical terms, to describe anatomical position relationships and their principle functions
- Musculoskeletal system
- Respiratory tract, digestive system and cardiovascular system
- Kidney and urinary system
- Spinal cord, brain and peripheral nerves
- Blood, immune system and endocrine system

Qualification-goals/Competencies:

- Students know the cell organelles and can describe their principle functions.
- Students are able to describe the basic function of the main body tissues: epithelial tissue, connective tissue, muscle tissue and nervous tissues.
- Students are able to name the anatomical regions of the human body using medical terms, to describe anatomical position relationships and their principle functions.
- Students are able to link main bones with respective body regions.
- Students are able to describe the structures and the principal functions of individual organ systems.
- Students have the competency to use the main medical terms.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. med. Jürgen Westermann

Teacher:

- Institute of Anatomy
- Prof. Dr. rer. nat. Kathrin Kalies

Literature:

- R. Eggers, O. Schmitt: Anatomie I + II - Skript zur Pflicht-Lehreinheit im Nebenfach Medizinische Informatik im Diplom-Studiengang Informatik. Hagen: Fern-Universität Hagen 2000
- A. Faller, M. Schünke: Der Körper des Menschen. Einführung in Bau und Funktion - Thieme: Stuttgart 2012

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):
- MZ2160-L1: Anatomy for technical courses, written exam, 30min, 100% of the submodule grade.

(Is module part of MZ2151, MZ2160)

MZ2100 B - Module Part: Course Pathology (Patho)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	3

Course of study, specific field and term:

- Bachelor MES 2020 (Module part of a compulsory module), medicine, 1st semester
- Bachelor Medical Informatics 2019 (Module part of a compulsory module), medical computer science, 3rd semester
- Bachelor Medical Informatics 2014 (Module part of a compulsory module), medical computer science, 3rd semester
- Bachelor MES 2014 (Module part of a compulsory module), medicine, 1st semester
- Bachelor Medical Informatics 2011 (Module part of a compulsory module), medical computer science, 1st semester
- Bachelor MES 2011 (Module part of a compulsory module), medicine, 1st semester
- Bachelor Computer Science 2012 (Module part of a compulsory module), specialization field medical informatics, 3rd semester

Classes and lectures:

- Pathology (lecture, 2 SWS)

Workload:

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

Contents of teaching:

- To place the specialty of pathology in the context of medicine as a whole (looking to history and future)
- Specific methods of investigation in pathology
- To define terms like health, illness, death, aetiology, pathogenesis
- To define typical terms of medical statistics
- Description of morphological changes of cells and tissue with implications to diagnosis
- Basic mechanisms of pathogenesis, typical clinical progression of disease in different organ systems
- IT- applications in the area of pathology which support diagnostic work (Lab-devices, interfaces to connect lab and clinical systems as well as a private doctor s office, tele pathology)

Qualification-goals/Competencies:

- Students are able to relate important historical dates and persons of pathology to diagnostic methods. They can describe methods like descriptive pathology, gross section, immunohistochemistry and molecular pathology.
- They are able to define terms like health, illness, death, aetiology and pathogenesis. Evaluating a case report, they will recognize the right definition.
- They are able to evaluate a given problem and determine approptiate descriptive terms like incidence or mortality.
- They are able to to analyse a small case report. They will recognize and explain different changes of cells and tissues in connection to a limited number of given diagnoses.
- They are able to name and describe different informatics application which are used in the pathology lab.
- They can specify the needs a pathologist will have to the technology. This will cover the benefit and the usability for the diagnostic work.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. med. Sven Perner

Teacher:

- Department of Pathology
- MitarbeiterInnen des Instituts
- Dipl.-Ing. Harald Hatje

Literature:

- W. Böcker, H. Denk, P. U. Heitz, H. Moch: Pathologie - Urban & Fischer Verlag/Elsevier GmbH, 2012
- M. Krams, S. O. Frahm, U. Kellner, C. Mawrin: Kurzlehrbuch Pathologie - Thieme 2013
- R. Kramme: Medizintechnik, Verfahren - Systeme Informationsverarbeitung - Springer 2011

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):
- MZ2160-L4: Pathology for technical courses, written exam, 30min, 100% of the submodule grade.

(Is module part of MZ2152, MZ2160)

Harald Hatje supports Prof. Perner in the pathology course and should therefore always be addressed.

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.-Ing. Thomas Eisenbarth

Teacher:

- Institute for IT Security
- Prof. Dr. 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.

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 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
- Bachelor Biophysics 2024 (optional subject), computer science, 6th 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. rer. nat. habil. Ralf Möller

Teacher:

- Institute of Information Systems
- Prof. Dr. rer. nat. habil. Ralf Möller

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.

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

ME1550 - Einführung in die Medizintechnik (EinfMedtec)

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

Course of study, specific field and term:

- Bachelor Medical Informatics 2011 (compulsory), medical computer science, 2nd semester
- Bachelor MES 2011 (compulsory), medical engineering science, 2nd semester
- Bachelor Computer Science 2012 (compulsory), specialization field robotics and automation, 2nd semester
- Bachelor Computer Science 2012 (compulsory), specialization field medical informatics, 2nd semester

Classes and lectures:

- Einführung in die Medizintechnik (lecture, 2 SWS)
- Einführung in die Medizintechnik (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Abriss zur historischen Entwicklung von Medizin und Medizintechnik
- Grundlagen der Anatomie und Physiologie
- Verfahren der Funktionsdiagnostik
- Bildgebende Systeme
- Therapiesysteme
- Monitoring
- Medizinische Informationsverarbeitung
- Wichtige gesetzliche Vorschriften
- Medizintechnische Anwendungen

Qualification-goals/Competencies:

- Grundlagen der medizinischen Messtechnik
- Verständnis komplexer Zusammenhänge bei der Messtechnik physiologischer Parameter
- Kompetenz im Umgang mit Messunsicherheiten

Grading through:

- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr. rer. nat. Thorsten Buzug

Teacher:

- Institute of Medical Engineering
- MitarbeiterInnen des Instituts
- Prof. Dr. rer. nat. Thorsten Buzug

Literature:

- :
- :
- :
- :
- :

Language:

- offered only in German

MZ2100 D - Module Part: Course Physiology (Physio)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	3

Course of study, specific field and term:

- Bachelor MES 2020 (Module part of a compulsory module), medicine, 2nd semester
- Bachelor Medical Informatics 2019 (Module part of a compulsory module), medical computer science, 2nd semester
- Bachelor Medical Informatics 2014 (Module part of a compulsory module), medical computer science, 2nd semester
- Bachelor MES 2014 (Module part of a compulsory module), medicine, 2nd semester
- Bachelor MES 2011 (Module part of a compulsory module), medicine, 2nd semester
- Bachelor Medical Informatics 2011 (Module part of a compulsory module), medical computer science, 2nd semester

Classes and lectures:

- Physiology (lecture, 2 SWS)

Workload:

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

Contents of teaching:

- Basic cell physiology
- Blood & immune system
- Heart & circulation
- Respiration
- Nutrition, intestinal tract, liver
- Energy and heat metabolism
- Water and electrolyte balance, kidney function
- Endocrine system
- Central and autonomous nervous system
- Muscle physiology
- Sensory physiology

Qualification-goals/Competencies:

- Students are able to explain the concepts of interaction of different cells and tissues of the human body.
- Students are able to formalize and interpret the principles of cellular communication in selected organ systems.
- Students are able to transfer principles of cellular communication and tissue homeostasis to new systems.
- Students are able to define physiological problems and transfer them to experimental approaches.
- Students are able to interpret assay patterns in physiological sciences and apply them to new systems/problems.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Henrik Oster

Teacher:

- Institute of Neurobiology
- Prof. Dr. rer. nat. Henrik Oster
- Dr. rer. nat. Violetta Pilorz

Literature:

- C. & A. Hick: Kurzlehrbuch Physiologie - München: Urban & Fischer (Elsevier)
- L.S. Costanzo: BRS Physiology - Philadelphia: Lippincott Williams & Wilki

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):
- MZ2160-L2: Physiology for technical courses, written exam, 90min, 100% of the submodule grade.

(Is module part of MZ2151, MZ2160)

MZ2100 E - Module Part: Course Cell Biology and Genetics (Zellbio)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	3

Course of study, specific field and term:

- Bachelor Medical Informatics 2014 (Module part of a compulsory module), medical computer science, 4th semester
- Bachelor MES 2011 (Module part of a compulsory module), medical engineering science, 2nd semester
- Bachelor Medical Informatics 2011 (Module part of a compulsory module), medical computer science, 2nd semester

Classes and lectures:

- Cell Biology and Genetics (lecture, 2 SWS)

Workload:

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

Contents of teaching:

- Structure and functions of biological macromolecules
- Internal organization and functioning of cells
- Molecular genetics and gene regulation, epigenetics
- Flow of genetic information; genotype vs. phenotype
- Cell cycle
- Classical genetics
- Human genetics and inheritable diseases
- Ecological aspects of medicine (Interactions of humans, microbes, & environment)

Qualification-goals/Competencies:

- Ability, to understand and reproduce the basics in the areas listed under content of teaching and to use them in the further studies

Grading through:

- written exam

Is requisite for:

- Molecular Genetics (LS3100)

Responsible for this module:

- Prof. Dr. rer. nat. Enno Hartmann

Teacher:

- Institute for Biology
- Prof. Dr. rer nat. Rainer Duden
- PD Dr. rer. nat. Bärbel Kunze
- Dr. rer. nat. Nicole Sommer

Literature:

- Markl (Hrsg.): Biologie - Klett 2010 (ISBN: 978-3-12-150010-9)

Language:

- offered only in German

CS2300 - Software Engineering I (SWTech)

Duration:	Turnus of offer:	Credit points:	Max. group size:
2 Semester	each winter semester	8	12

Course of study, specific field and term:

- Bachelor Medical Informatics 2011 (compulsory), computer science, 3rd and 4th semester
- Bachelor CLS 2010 (optional suject), computer science, 5th and 6th semester
- Bachelor Computer Science 2012 (compulsory), foundations of computer science, 3rd and 4th semester

Classes and lectures:

- Software Engineering I (lecture, 2 SWS)
- Software Engineering I (exercise, 1 SWS)
- Software Engineering I (practical course, 3 SWS)

Workload:

- 60 Hours private studies and exercises
- 45 Hours in-classroom work
- 45 Hours in-classroom work
- 40 Hours group work
- 35 Hours work on project
- 15 Hours exam preparation

Contents of teaching:

- overview on major fields of software engineering
- Software development, software process models
- Basic concepts of software sysems
- System analysis and requirements engineering
- Software design and software architectures
- Implementation
- Testing and integration
- Installation, acceptance, maintainance

Qualification-goals/Competencies:

- Understanding software design as an engineering process
- Kowledge of major software process models and description formalisms for software artefacts
- Ability to model software systemson different levels of abtraction
- Ability to systematically design software systems whose implemention meets the requirements
- Knowing the basic concepts of object-oriented modelling and design
- Usage of UML and CASE tools
- Qualification to work in a team,to present artefacts, to comply tostandards and to observe time limits

Grading through:

- Written or oral exam as announced by the examiner

Requires:

- Algorithms and Data Structures (CS1001-KP08, CS1001)
- Programming (CS1000)

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 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

CS1400-KP04, CS1400 - Introduction to Bioinformatics (EinBioinfo)

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 Nutritional Medicine 2024 (compulsory), mathematics / computer science, 5th semester
- Bachelor Molecular Life Science 2024 (compulsory), mathematics / computer science, 5th semester
- Bachelor MES 2020 (optional subject), computer science / electrical engineering, 3rd semester at the earliest
- Bachelor Computer Science 2019 (compulsory), Canonical Specialization Bioinformatics and Systems Biology, 1st semester
- Bachelor Computer Science 2019 (optional subject), Introductory Module Computer Science, 1st semester
- Bachelor MLS 2018 (compulsory), life sciences, 5th semester
- Bachelor MES 2014 (optional subject), computer science / electrical engineering, 3rd semester at the earliest
- Bachelor Computer Science 2016 (optional subject), Introductory Module Computer Science, 1st semester
- Bachelor Computer Science 2016 (compulsory), Canonical Specialization Bioinformatics, 1st semester
- Bachelor MLS 2016 (compulsory), life sciences, 5th semester
- Bachelor Medical Informatics 2014 (compulsory), medical computer science, 3rd semester
- Bachelor Computer Science 2014 (compulsory), specialization field bioinformatics, 1st semester
- Bachelor Medical Informatics 2011 (compulsory), medical computer science, 3rd semester
- Bachelor MLS 2009 (compulsory), life sciences, 5th semester
- Bachelor CLS 2010 (compulsory), specialization field bioinformatics, 5th semester
- Bachelor MES 2011 (optional subject), medical engineering science, 3rd or 5th semester
- Bachelor Computer Science 2012 (compulsory), specialization field bioinformatics, 1st semester
- Bachelor Biophysics 2024 (optional subject), computer science, 5th semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

- Life, Evolution & the Genome
- Sequence assembly - Industrial reading of genetic information
- DNA sequence models & hidden markov models
- Viterbi-Algoritm
- Sequence alignment & dynamic programming
- Unsupervised data analysis (k-means, PCA, ICA)
- DNA microarrays & GeneChip technologies

Qualification-goals/Competencies:

- Students are able to explain the basic concepts of coding, transcription and translation of information in living beings.
- They are able to explain how a solution of the shortest common superstring problem can be estimated with a simple greedy algorithm.
- They are able to create a Markov chain or a Hidden Markov Model (HMM) for a given modelling problem.
- They are able to give examples on how to solve a problem using dynamic programming.
- They are able to implement the introduced algorithms (in Matlab)
- They are able to use unsupervised learning methods and they are able to interpret the results.
- They are able to explain basic Microarray-and DNA-Chip-Technologies.

Grading through:

- portfolio exam

Responsible for this module:

- Prof. Dr. rer. nat. Amir Madany Mamlouk

Teacher:

- Institute for Neuro- and Bioinformatics
- Prof. Dr. rer. nat. Amir Madany Mamlouk

Literature:

- H. Lodish, A. Berk, S. L. Zipursky and J. Darnell: Molekulare Zellbiologie - Spektrum Akademischer Verlag, 4. Auflage, 2001, ISBN-13: 978-3827410771
- A. M. Lesk: Introduction to Bioinformatics - Oxford University Press, 3. Auflage, 2008, ISBN-13: 978-0199208043
- R. Merkl and S. Waack: Bioinformatik Interaktiv: Grundlagen, Algorithmen, Anwendungen - Wiley-VCH Verlag, 2. Auflage, 2009, ISBN-13: 978-3527325948
- M. S. Waterman: Introduction to Computational Biology - Chapman and Hall, 1995

Language:

- offered only in German

Notes:

For students of the master programme Infection Biology, this is not a stand-alone module, but rather part of the module CS4011.

Prerequisites for attending the module:
- None

Computer Science students get a B certificate.

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

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
- 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

MZ4010-KP04, MZ4010 - Clinical Epidemiology (KlinEpi)

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

Course of study, specific field and term:

- Master CLS 2023 (compulsory), MML with specialization in Genetic Statistics, 3rd semester
- Bachelor Medical Informatics 2019 (optional subject), medical computer science, 4th to 6th semester
- Master CLS 2016 (compulsory), MML with specialization in Genetic Statistics, 3rd semester
- Bachelor Medical Informatics 2014 (compulsory), medical computer science, 5th semester
- Bachelor Medical Informatics 2011 (compulsory), medical computer science, 3rd semester
- Master CLS 2010 (compulsory), computational life science / biostatistics, 1st semester
- Master Computer Science 2012 (compulsory), specialization field medical informatics, 3rd semester

Classes and lectures:

- Clinical Epidemiology (lecture, 2 SWS)
- Clinical Epidemiology (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Introduction to epidemiology
- Diagnosis
- Frequencies
- Registers and data sources
- Geographical epidemiology
- Study designs (RCT, cohort study, case control study, cross sectional study)
- Effect measures
- Causality
- Chance, bias and confounding
- Control of errors
- Outbreak investigation

Qualification-goals/Competencies:

- Students are able to explain technical terms such as disease register, incidence, prevalence, mortality, lethality, standardization.
- They are able to explain and interpret epidemiological measures.
- They are able to assess which study design is appropriate for a certain research question.
- They are able to identify possible sources of error, bias and confounding and how they affect the study results.
- They are able to assess causal inferences in the context of different study types.
- They are able to critically appraise data, results, and epidemiological research methods as well as scientific literature in the context of medicine and epidemiology.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. med. Alexander Katalinic

Teacher:

- Institute for Social Medicine and Epidemiology
- Prof. Dr. med. Alexander Katalinic
- MitarbeiterInnen des Instituts

Literature:

- L. Gordis: Epidemiology - Oxford: Elsevier; 5th edition 2013
- R. H. Fletcher: Clinical Epidemiology. The Essentials. - Lippincott Williams & Wilki; 5th rev. edition 2012
- :

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

Prerequisites for participation in the exam(s):
- None

Module exam(s):
- MZ4010-L1, Clinical Epidemiology, written exam, 90 min, 100 % of module grade

CS1200-MI - Fundamentals of Computer Engineering (TGI)

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

Course of study, specific field and term:

- Bachelor Medical Informatics 2011 (compulsory), computer science, 4th semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

- Boolean algebra
- Switching functions
- Minimization
- Combinational logic
- Sequential logic
- Register-transfer languages
- Data processing units
- Control units
- Microprogramming
- Basic processor architectures
- Microcontrollers
- Assembler programming
- I/O-interfaces
- Interrupts
- Semiconductor components
- Circuit families
- Integraded circuits
- Programmable logic
- CAD-tools
- Memory technologies

Qualification-goals/Competencies:

- Students know the most important methods for the formal description of digital circuits like Boolean algebra or register-transfer languages
- They are well acquainted with the basic design methods for digital circuits on gate and register-transfer level
- They have knowledge about basic processor architectures and their programming in machine language
- They know the basic technologies for the realization of digital circuits (bipolar, MOS, CMOS)

Grading through:

- Viva Voce or test

Is requisite for:

- Laboratory Fundamentals of Computer Engineering (CS1201)

Responsible for this module:

- Prof. Dr.-Ing. Mladen Berekovic

Teacher:

- Institute of Computer Engineering
- 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 Prentice Hall 2007

- M. M. Mano, M.D. Ciletti: Digital Design - Pearson Prentice Hall 2012
- C. H. Roth, L.L. Kinney: Fundamentals of Logic Design - Cengage Learning Services 2009
- W. Schiffmann, R. Schmitz: TechnW. Schiffmann, R. Schmitz - Berlin: Springer 2004
- W. Schiffmann, R. Schmitz: Technische Informatik 2 - Grundlagen der Computertechnik - Berlin: Springer 2005

Language:

- offered only in German

CS2150 - Computer Networks (CN)

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

Course of study, specific field and term:

- Bachelor Medical Informatics 2011 (compulsory), computer science, 4th semester
- Bachelor MES 2011 (optional subject), Applied computer science, 6th semester
- Bachelor Computer Science 2012 (compulsory), foundations of computer science, 4th semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

- Computer Networks and the Internet
- Application Layer
- Transport Layer
- Network Layer
- Link and Physical Layer

Qualification-goals/Competencies:

- 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 andservices 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

Literature:

- James Kurose, Keith Ross: Computer Networking - Der Top-Down-Ansatz - Pearson Studium, 2012
- Andrew S. Tanenbaum: Computernetzwerke - Pearson Studium, 2012

Language:

- offered only in German

CS3300-MI - Informatics in Health Care - eHealth (eHealth)

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

Course of study, specific field and term:

- Bachelor Medical Informatics 2011 (compulsory), medical computer science, 4th semester

Classes and lectures:

- Medical information science (lecture, 2 SWS)
- Medical information science (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Health Care System: organization, legislation and funding
- Distributed patient care and patient records
- Medical Documentation and Communication
- Coding of diagnoses and procedures
- Hospital Information Systems
- DRG-based compensation system and accounting of cases
- Telematics in medicine: electronic health insurance card

Qualification-goals/Competencies:

- Insight into the methods and procedures of subfields of medical informatics
- Ability to independent processing of selected tasks with specialized tools
- Ability to assess the upcoming IT challenges in view of the current political and economical developments in the health care system

Grading through:

- Written or oral exam as announced by the examiner

Responsible for this module:

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

Teacher:

- Institute of Medical Informatics
- Prof. Dr. rer. nat. habil. Josef Ingenerf

Literature:

- T. Lehmann: Handbuch der Medizinischen Informatik - München: Hanser 2004
- P. Haas: Medizinische Informationssysteme und Elektronische Krankenakten - Berlin: Springer 2005
- J. Ingenerf, R. Linder, S. J. Pöppl: Informatik im Gesundheitswesen - Skript zur Pflicht-Lehreinheit im Nebenfach Medizinische Informatik im Diplom-Studiengang Informatik - Hagen: Fern-Universität Hagen 2002

Language:

- offered only in German

MA1600-KP04, MA1600, MA1600-MML - Biostatistics 1 (BioStat1)

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

Course of study, specific field and term:

- Bachelor CLS 2023 (compulsory), mathematics, 2nd semester
- Bachelor Biophysics 2024 (compulsory), Elective Computer Science, 4th semester
- Bachelor Nutritional Medicine 2024 (compulsory), mathematics / natural sciences, 4th semester
- Bachelor MES 2014 (optional subject), mathematics / natural sciences, 3rd semester at the earliest
- Bachelor Computer Science 2019 (optional subject), Extended optional subjects, Arbitrary semester
- Bachelor Computer Science 2019 (compulsory), Canonical Specialization Bioinformatics and Systems Biology, 6th semester
- Bachelor Medical Informatics 2019 (compulsory), medical computer science, 6th semester
- Bachelor MLS 2018 (compulsory), life sciences, 6th semester
- Bachelor Nutritional Medicine 2018 (compulsory), mathematics / computer science, 6th semester
- Bachelor CLS 2016 (compulsory), mathematics, 2nd semester
- Bachelor CLS 2010 (compulsory), mathematics, 2nd semester
- Bachelor Computer Science 2016 (optional subject), advanced curriculum, Arbitrary semester
- Bachelor Computer Science 2016 (compulsory), Canonical Specialization Bioinformatics, 4th semester
- Bachelor MLS 2016 (compulsory), life sciences, 6th semester
- Bachelor Biophysics 2016 (compulsory), Elective Computer Science, 4th semester
- Bachelor Nutritional Medicine 2016 (compulsory), mathematics / computer science, 6th semester
- Bachelor Medical Informatics 2014 (compulsory), medical computer science, 4th semester
- Bachelor Computer Science 2014 (compulsory), specialization field bioinformatics, 6th semester
- Master MES 2011 (advanced curriculum), biophysics and biomedical optics, 2nd semester
- Bachelor Medical Informatics 2011 (compulsory), medical computer science, 4th semester
- Master Computer Science 2012 (optional subject), specialization field bioinformatics, 2nd or 3rd semester
- Master Computer Science 2012 (compulsory), advanced curriculum stochastics, 2nd semester
- Bachelor Computer Science 2012 (optional subject), specialization field bioinformatics, 6th semester
- Bachelor MLS 2009 (compulsory), life sciences, 6th semester
- Bachelor MES 2011 (optional subject), medical engineering science, 6th semester
- Bachelor Molecular Life Science 2024 (compulsory), mathematics / computer science, 4th semester

Classes and lectures:

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

Workload:

- 66 Hours private studies
- 39 Hours in-classroom work
- 15 Hours exam preparation

Contents of teaching:

- Descriptive statistics
- Probability theory, including random variables, density, and cumulative distribution function
- Normal distribution, other distributions
- Diagnostic tests, reference range, normal range, coefficient of variation
- Statistical testing
- Sample size calculations
- Confidence intervals
- Selected statistical tests I
- Selected statistical tests II
- Linear simple regression
- Analysis of variance (one-way-classification)
- Clinical trials
- Multiple Testing: Bonferroni, Bonferroni-Holm, Bonferroni-Holm-Shaffer, Wiens, hierarchical Testing

Qualification-goals/Competencies:

- With regard to the roles of GSP of the University of Lübeck and of the DFG-guidelines the student were able to work with the following statistical methods:The students are able to calculate descriptive statistics.
- They are able to calculate quantiles and surfaces of the normal distribution.
- They are able to explain terms of diagnostic testing, such as sensitivity or specificity.
- They are able to list the basic principles of statistical testing, sample size calculation and confidence interval construction.

- They are able to carry out a set of elementary statistical tests, such as t-test, test of proportions, X2 independence test, and to interpret the results.
- They are able to explain the basic principles of linear regression.
- They are able to apply the linear simple regression.
- They are able to explain the basic idea for the one-way analysis of variance (ANOVA).
- They are able to explain the results table for the one-way and two-way ANOVA.
- They are able to interpret the results of the ANOVA.
- They know the basic principles of clinical therapeutic studies.
- They know the assumptions that need to be fulfilled for the application of specific statistical tests.
- They are able to calculate simple adjustments for multiple comparisons.

Grading through:

- written exam

Is requisite for:

- Module part: Biostatistics 2 (MA2600 T)
- Biostatistics 2 (MA2600-KP07)
- Biostatistics 2 (MA2600-KP04, MA2600)

Responsible for this module:

- Prof. Dr. rer. biol. hum. Inke König

Teacher:

- Institute of Medical Biometry and Statistics

- Prof. Dr. rer. biol. hum. Inke König
- MitarbeiterInnen des Instituts

Literature:

- Matthias Rudolf, Wiltrud Kuhlisch: Biostatistik: Eine Einführung für Biowissenschaftler - 1. Auflage, Pearson: Deutschland
- Lothar Sachs, Jürgen Hedderich: Angewandte Statistik: Methodensammlung mit R - 15. Auflage, Springer: Heidelberg

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Active and regular participation in the exercise groups as specified at the beginning of the semester.

Module exam:
-MA1600-L1: Biostatistics 1, 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

CS1100 - Operating systems (BetriebSys)

Duration:	Turnus of offer:	Credit points:
1 Semester	on request	4

Course of study, specific field and term:

- Bachelor Medical Informatics 2011 (optional subject), computer science, 4th to 6th semester
- Bachelor Computer Science 2012 (compulsory), foundations of computer science, 1st semester

Classes and lectures:

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

Workload:

- 65 Hours private studies
- 45 Hours in-classroom work
- 10 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)

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.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. Stefan Fischer

Teacher:

- Institute of Telematics

- Prof. Dr. Stefan Fischer
- Prof. Dr.-Ing. Andreas Schrader

Literature:

- Andrew S. Tanenbaum: Moderne Betriebssysteme - 3., aktualisierte Auflage, Pearson, April 2009

Language:

- offered only in German

CS1201 - Laboratory Fundamentals of Computer Engineering (PrakTGI)

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

Course of study, specific field and term:

- Bachelor Medical Informatics 2011 (optional subject), computer science, 4th to 6th semester

Classes and lectures:

- Fundamentals of Computer Engineering (practical course, 3 SWS)

Workload:

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

Contents of teaching:

-

Qualification-goals/Competencies:

- They are able to design simple digital circuits making use of CAD-tools, to implement and test them in different technologies (TTL, FPGAs etc.)
- They are able to program microcontrollers for simple applications in assembly language

Grading through:

- continuous, successful participation in practical course

Requires:

- Fundamentals of Computer Engineering (CS1200-MI)

Responsible for this module:

- Prof. Dr.-Ing. Mladen Berekovic

Teacher:

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

Literature:

- :

Language:

- offered only in German

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

CS2102 - Computer Architecture (RA)

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

Course of study, specific field and term:

- Bachelor Medical Informatics 2011 (optional subject), computer science, 4th to 6th 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
- Multiprocessors, multicomputer
- Vector processors, array processors
- Performance evaluation
- Parallel computer architectures

Qualification-goals/Competencies:

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

Grading through:

- Viva Voce or test

Requires:

- Fundamentals of Computer Engineering (CS1200-MI)

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 Studim, 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

CS2200-KP04, CS2200 - Software Ergonomics (SoftErgo)

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

Course of study, specific field and term:

- Bachelor IT-Security 2016 (optional subject), specific, Arbitrary semester
- Bachelor Media Informatics 2020 (compulsory), media informatics, 2nd semester
- Bachelor Psychology 2016 (optional subject), computer science, Arbitrary semester
- Bachelor Psychology 2013 (optional subject), computer science, Arbitrary semester
- Bachelor Media Informatics 2014 (compulsory), media informatics, 2nd semester
- Bachelor Medical Informatics 2011 (optional subject), software engineering, 4th to 6th semester
- Bachelor Computer Science 2012 (compulsory), foundations of computer science, 2nd semester

Classes and lectures:

- Software Ergonomics (lecture, 2 SWS)
- Software Ergonomics (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Motivation and introduction
- Models of HCI
- Modes of input & input devices
- Modes of output & output devicdes
- Time behavior of interactive systems
- Graphical control elements
- Usability and usability processes
- Digital work

Qualification-goals/Competencies:

- The students know the basic theories, models and criteria for user- and application-centered interactive multimedia systems.
- They are able to transfer this knowledge into development processes and to evaluate interactive systems systematically.
- They can describe work systems as well as applications in education and entertainment in a user- and task-centered way.

Grading through:

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

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:

- M. Herczeg: Software-Ergonomie - 4. Auflage, München: Oldenbourg-Verlag, 2018
- Jetter, H.: D 3 Mensch-Computer-Interaktion, Usability und User Experience - In R. Kuhlen, D. Lewandowski, W. Semar & C. Womser-Hacker (Ed.), Grundlagen der Informationswissenschaft (pp. 525-534). Berlin, Boston: De Gruyter Saur.

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

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

Exams:
- CS2200-L1 Software-Ergonomie, oral exam, 50% of the grade
- CS2200-L1 Software-Ergonomie, portfolio exam, 50% of the grade during the 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)

CS2600 - Interaction Design (InterakDes)

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

Course of study, specific field and term:

- Bachelor Computer Science 2012 (optional subject), central topics of computer science, 5th semester
- Bachelor Medical Informatics 2011 (optional subject), computer science, 4th to 6th semester
- Bachelor Computer Science 2012 (compulsory), specialization field media informatics, 3rd semester

Classes and lectures:

- Interaction Design (lecture with exercises, 3 SWS)

Workload:

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

Contents of teaching:

- Introduction and overview
- Basic models of multimedia and interactive systems
- System paradigms
- Design patterns
- Modalities of interaction
- Information output and output devices
- Information input and input devices
- Help systems
- History systems
- Activity management systems
- Individualization of interactive systems
- Summary

Qualification-goals/Competencies:

- The students are able to use systematically and theoretically founded methods for the design of user interfaces of interactive systems.
- Besides the psychological and computer science basics they build up knowledge about methods from the areas of graphic design and communication design.
- They are capable of categorizing existing systems and develop concepts for improving them.

Grading through:

- written exam

Is requisite for:

- Lab class media and interaction design (CS3600)
- Media Production and Media Programming (CS2601)
- Usability Engineering (CS3201-KP04, CS3201)

Requires:

- Software Ergonomics (CS2200-KP04, CS2200)

Responsible for this module:

- Dr. Thomas Winkler

Teacher:

- Institute for Multimedia and Interactive Systems
- Dr. Thomas Winkler

Literature:

- M. Herczeg: Interaktionsdesign - Oldenbourg-Verlag, 2006
- B. Shneiderman, C. Plaisant: Designing the User Interface - Addison-Wesley, 2009

Language:

- offered only in German

CS3200 - Software Engineering II (SWEng)

Duration:	Turnus of offer:	Credit points:
1 Semester	not available anymore	4

Course of study, specific field and term:

- Bachelor Medical Informatics 2011 (optional subject), software engineering, 4th to 6th semester
- Bachelor CLS 2010 (optional subject), computer science, 5th or 6th semester
- Bachelor MES 2011 (compulsory), foundations of computer science, 5th semester
- Bachelor Computer Science 2012 (compulsory), foundations of computer science, 5th semester

Classes and lectures:

- Software Engineering II (lecture, 2 SWS)
- Software Engineering II (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Introduction to software engineering
- Software management
- Software quality assurance
- Software evolution
- Software reuse
- Re-engineering and phase-out
- Software productivity, expense, and estimation
- Legal aspects

Qualification-goals/Competencies:

- Knowing the basic procedures of software engineering
- Quality awareness
- Knowing activities and factors of software management
- Ability to organize software projects and to evaluate software engineering processes
- Understanding software evolution

Grading through:

- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr. Martin Leucker

Teacher:

- Institute of Software Technology and Programming Languages
- PD Dr. Gerhard Buntrock

Literature:

- H. Balzert: Lehrbuch der Software-Technik: Software-Management, Software-Qualitätssicherung - Akademischer Verlag 1998
- A. Behforooz, F. J. Hudson: Software Engineering Fundamentals - Oxford University Press 1996
- C. Ghezzi, M. Jazayeri, D. Mandrioli: Fundamentals of Software Engineering - Prentice Hall 2002
- B. Hughes, M. Cotterell: Software Project Management - McGraw-Hill 1999
- I. Sommerville: Software Engineering - Addison Wesley 2006

Language:

- offered only in German

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

CS3202-KP04, CS3202 - Nonstandard Database Systems (NDB)

Duration:	Turnus of offer:	Credit points:
1 Semester	not available anymore	4

Course of study, specific field and term:

- 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, 5th or 6th semester
- Bachelor Medical Informatics 2011 (optional subject), Applied computer science, 4th to 6th semester
- Master Computer Science 2012 (optional subject), specialization field media informatics, 2nd or 3rd semester
- Master CLS 2010 (optional suject), computer science, Arbitrary semester
- Bachelor CLS 2010 (optional subject), computer science, 6th semester
- Master Computer Science 2012 (optional subject), advanced curriculum distributed information systems, 2nd or 3rd semester
- Bachelor Computer Science 2012 (optional subject), central topics of computer science, 5th or 6th semester

Classes and lectures:

- Nonstandard Database Systems (lecture, 2 SWS)
- Nonstandard Database Systems (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- introduction
- semistructured databases
- Temporal and spatial databases (temporally restricted validity, multidimensional index structures)
- Sequence Databases
- Databases for data streams (window concept)
- Databases for incomplete information (e.g., constraint databases)
- Probabilistic databases
- Databases with answer ranking (top-k queries)

Qualification-goals/Competencies:

- Knowledge:Students can name the main features of standard databases and, in addition, can explain which non-standard database models emerge if features are dropped. They can describe the main ideas behind non-standard databases presented in the course by explaining the main features of respective query languages (syntax and semantics) as well as the most important implementation techniques used for their practical realization.
- Skills:Students can apply query languages for non-standard data models introduced in the course to retrieve desired structures from sample datasets in order to satisfy information needs specified textually in natural language. Students are able to represent data in the relational data model using encoding techniques presented in the course such that they can demonstrate how new formalisms relate to or can be implemented in SQL (in particular, SQL-99). In case an SQL transformation cannot be found, students can explain and apply dedicated algorithms for query answering. Students can demonstrate how index structures help answering queries fast by showing how index structures are built, updated, and exploited for query answering. The participants of the course can derive query answers by evaluating queries step by step and by deriving optimized query execution plans.
- Social skills:Students work in teams to handle assignments, and they are encouraged to present their solution to other students in small presentations (in lab classes). In addition, self-dependence is fostered by giving pointers to query evaluation engines for various formalism presented in the lecture such that students get familiar with data models and query languages by self-controlled work.

Grading through:

- Written or oral exam as announced by the examiner

Requires:

- Databases (CS2700-KP04, CS2700)

Responsible for this module:

- Prof. Dr. rer. nat. habil. Ralf Möller

Teacher:

- Institute of Information Systems

- Prof. Dr. rer. nat. habil. Ralf Möller

Literature:

- S. Abiteboul, P. Buneman, D. Suciu: Data on the Web - From Relations to Semistructured Data and XML - Morgan Kaufmann, 1999
- J. Chomicki, G. Saake (Eds.): Logics for Databases and Information Systems - Springer, 1998
- P. Rigaux, M. Scholl, A. Voisard: Spatial Databases With Applications to GIS - Morgan Kaufmann, 2001
- P. Revesz: Introduction to Constraint Databases - Springer, 2002
- P. Revesz: Introduction to Databases- From Biological to Spatio-Temporal - Springer 2010
- S. Ceri, A. Bozzon, M. Brambilla, E. Della Valle, P. Fraternali, S. Quarteroni: Web Information Retrieval - Springer, 2013
- S. Chakravarthy, Q. Jiang: Stream Data Processing A Quality of Service Perspective - Springer, 2009
- D. Suciu, D. Olteanu, Chr. Re, Chr. Koch: Probabilistic Databases - Morgan & Claypool, 2011

Language:

- offered only in German

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)

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

CS3810 - Image and Signal Processing in Medicine 2 (MBS2)

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

Course of study, specific field and term:

- Bachelor Medical Informatics 2011 (optional subject), medical computer science, 4th to 6th semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

- Advanced methods for the combined signal and image analysis
- Methods for the automatic determination of anatomical landmarks
- Methods for finding correspondences in medical image data
- Methods of non-linear image registration
- Fusion of medical imaging data and image-based motion field estimation
- Methods for pattern recognition in medical data
- Methods for extraction and selection of image features
- Feature-based segmentation using statistical classifiers and neural networks
- Methods of atlas-based image segmentation and recognition
- Methods for image-based generation of finite element models
- Image-based modeling and simulation of physiological processes
- Examples

Qualification-goals/Competencies:

- Knowledge of advanced methods for combined analysis of signal and image sequences in medicine
- Knowledge of advanced methods for image registration, image recognition and image-based modeling
- Ability to evaluate, select and apply appropriate methods and algorithms
- Advanced overview of the scope of medical image processing with many examples
- Advanced ability to process and analyze medical images

Grading through:

- Written or oral exam as announced by the examiner

Requires:

- Medical Imaging, Image and Signal Computing (ME3000)

Responsible for this module:

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

Teacher:

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

Literature:

- H. Handels: Medizinische Bildverarbeitung - Stuttgart: Vieweg &Teubner 2009
- M. Sonka, V. Hlavac, R. Boyle: Image Processing, Analysis and Machine Vision - 2nd edition. Pacific Grove: PWS Publishing 1998

Language:

- offered only in German

CS3820 - Decision support in medicine (EntscheidM)

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

Course of study, specific field and term:

- Bachelor Medical Informatics 2011 (optional subject), medical computer science, 4th to 6th semester

Classes and lectures:

- Decision support in medicine (lecture, 2 SWS)
- Decision support in medicine (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Decision support in evidence-based medicine (EbM)
- Information systems versus knowledge-based systems
- From the published knowledge (including MEDLINE) via reviews (including Cochrane) and guidlines to IT-based interpretation (GLIF & Arden Syntax) in knowledge-based systems
- Decision support in consideration of complexity, uncertainty and incompleteness
- Basic methods from artificial intelligence to represent and infer knowledge
- Methods for decision support in medicine: declarative approaches, machine learning approches , case based reasoning and expert systems
- Data Warehouse and Data Mining - Methods for identifying valid, novel, potentially useful and understandable pattern in datasets.
- Examples: effective provision of knowledge on clinical work station, scores and diagnostical tests, drug safety, expert systems for diagnostic in laboratories
- Other issues with regard to the applicability of systems for decision support in practice, including knowledge acquisition, interpretation of patient data, acceptance of computer-aided decision support by doctors and nurses

Qualification-goals/Competencies:

- Insight into processes and applications for decision support in medicine
- Knowledge of various procedures for representation and processing of medical knowledge
- Knowledge of the essential conditions with regard to the initialisation of decision support systems in the clinical application

Grading through:

- Written or oral exam as announced by the examiner

Responsible for this module:

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

Teacher:

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

Literature:

- Th. Lehmann: Handbuch der Medizinischen Informatik - 2. Auflage: München: Hanser 2004
- C. Spreckelsen, K. Spitzer: Wissensbasen und Expertensysteme in der Medizin - Wiesbaden: Vieweg+Teubner, 2008
- C. Beierle, G. Kern-Isberner: Methoden wissensbasierter Systeme - 4. Auflage, Wiesbaden: Vieweg+Teubner, 2008
- P. Haas, B. Breil: Wissensmanagement und wissensbasierte Systeme - Berlin: Springer, 2012
- SAS: Data Mining Using SAS Enterprise Miner: A Case Study Approach - 2nd Edition, SAS Publishing, 2003

Language:

- offered only in German

CS3830-KP04, CS3830 - Programming for Medical Image Processing in C++ (PmBV)

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

Course of study, specific field and term:

- Bachelor MES 2014 (optional subject), medical engineering science, 4th or 6th semester
- Master Medical Informatics 2014 (optional subject), medical image processing, 1st or 2nd semester
- Bachelor Medical Informatics 2014 (optional subject), medical computer science, 5th or 6th semester
- Bachelor Medical Informatics 2011 (optional subject), medical computer science, 4th to 6th semester

Classes and lectures:

- Programming for Medical Image Processing in C++ (lecture, 1 SWS)
- Programming for Medical Image Processing in C++ (practical course, 2 SWS)

Workload:

- 70 Hours private studies
- 45 Hours in-classroom work
- 5 Hours oral presentation and discussion (including preparation)

Contents of teaching:

- Introduction to C++ programming for medical image processing
- File formats of medical data and data structure/types
- Vectors, Standard Template Library, Pairs and Tuples
- Class objects, functions and methods
- Loops, also in C++11, lambda functions
- Use of programming libraries (Eigen)
- Implementation of filters for medical image processing
- Dimensionality reduction using PCA
- Search and cluster trees for image processing
- Patch-based non-local means segmentation
- Fast-Fourier transform for template matching
- Integration of C++ in MATLAB (mex)
- Efficient programming for 3d medical images
- Parallel and SIMD programming techniques in C++
- Solve practical project in a team

Qualification-goals/Competencies:

- Students understand the specific challenges of programming for medical image processing.
- They know the basics of object orientated programming.
- They are able to implement local and regional pixel operators (filter, etc) independently.
- They know functions from STL and current trends in C++.
- They are proficient in solving large problems in limited time.
- They can design, implement and test programme code independently.
- They are able to develop practical algorithms for medical image processing based on theoretical concepts.
- They can tackle large scale problems together in teams.

Grading through:

- continuous, successful participation in practical course

Responsible for this module:

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

Teacher:

- Institute of Medical Informatics
- Prof. Dr. Mattias Heinrich

Literature:

- Lippman: C++ Primer - Addison-Wesley Longman, Amsterdam

Language:

- German and English skills required

Notes:

taught as compact course in spring term break (project during term)

LS1100-INF - Basic Chemistry (ChemINF)

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

Course of study, specific field and term:

- Bachelor MES 2014 (optional subject), mathematics / natural sciences, 3rd or 5th semester
- Bachelor Computer Science 2014 (compulsory), specialization field bioinformatics, 3rd semester
- Bachelor MES 2011 (optional subject), optional subject medical engineering science, 3rd or 5th semester
- Bachelor Medical Informatics 2011 (optional subject), bioinformatics, 4th to 6th semester
- Bachelor Computer Science 2012 (compulsory), specialization field bioinformatics, 3rd semester

Classes and lectures:

- Basic Chemistry (lecture, 2 SWS)
- Basic Chemistry (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Organisation of matter and the periodic table of the elements
- Chemical bonds, molecules and Ions
- Chemical formula and stoichiometry
- The threedimensional structure of molecules: From the VSEPR model to molecular orbitals
- Special properties of water
- Chemical Equilibrium
- Acids and Bases
- Redox reactions and electrochemistry
- Complexes and metal-ligand bonds
- Interactions between mater and radiation - Spectroscopy
- Thermodynamics
- Chemical Kinetics

Qualification-goals/Competencies:

- Understanding basic chemical concepts
- Basics of anorganic chemistry
-

Grading through:

- written exam

Responsible for this module:

- PD Dr. phil. nat. Thomas Weimar

Teacher:

- Institute of Chemistry and Metabolomics
- Dr. rer. nat. Kerstin Lüdtke-Buzug
- PD Dr. phil. nat. Thomas Weimar

Literature:

- Schmuck et al.: Chemie für Mediziner - Pearson Studium
- Binnewies et al.: Allgemeine und Anorganische Chemie - Spektrum

Language:

- offered only in German

LS3100 - Molecular Genetics (MolGen)

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

Course of study, specific field and term:

- Bachelor Medical Informatics 2011 (optional subject), bioinformatics, 4th to 6th semester
- Bachelor Computer Science 2012 (compulsory), specialization field bioinformatics, 5th semester

Classes and lectures:

- Molecular genetics for computer scientists (lecture, 1 SWS)
- Molecular genetics for computer scientists (practical course, 2 SWS)

Workload:

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

Contents of teaching:

- Structure of DNA
- Causes of mutations
- Generation of genetically modified bacteria (Designs of the experiment at the computer, isolation of DNA, restriction cutting of DNA, PCR, ligation of DNA into plasmids, transformation of bacteria, restriction analysis, sequencing of DNA)
- Molecular evolution of DNA and its analysis by bioinformatical methods

Qualification-goals/Competencies:

- Ability, to understand and reproduce theoretical knowledge in molecular genetics and apply it in the following studies
- Basic practical skills in molecular genetics including the use of bioinformatics in the daily laboratory routine

Grading through:

- written exam

Requires:

- Biology (LS2500-KP04, LS2500)

Responsible for this module:

- PD Dr. rer. nat. Bärbel Kunze

Teacher:

- Institute for Biology

- PD Dr. rer. nat. Bärbel Kunze
- Prof. Dr. rer. nat. Enno Hartmann
- Dr. rer. nat. Nicole Sommer

Literature:

- Campbell & Reece: Biologie - Pearson
- Purves, Sadava, Orians, Heller: Biologie - Spektrum
- Markl: Biologie - Klett
- T.A. Brown: Gentechnologie für Einsteiger - Spektrum

Language:

- offered only in German

Notes:

The module is passed if:
- 80% attendance, both in the practical part and in the lecture part
- submission of a complete test protocol
- Passing the written exam; more than 50% of the maximum number of points must be achieved

Block course at the end of the winter semester with a limited number of participants, registration required by January 15.

Admission requirement for the practical course is the passed exam from LS2500 Fundamentals of Biology or, for students on the Medical Informatics course, the sub-module MZ2100E.

MA2214-KP04, MA2214 - Clinical Studies (KlinStud)

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

Course of study, specific field and term:

- Bachelor CLS 2023 (compulsory), mathematics, 3rd or 5th semester
- Master Nutritional Medicine 2023 (compulsory), medical computer science, 1st semester
- Bachelor Medical Informatics 2019 (optional subject), medical computer science, 4th to 6th semester
- Bachelor CLS 2016 (compulsory), mathematics, 3rd or 5th semester
- Master Nutritional Medicine 2019 (compulsory), medical computer science, 1st semester
- Bachelor Medical Informatics 2014 (optional subject), medical computer science, 5th or 6th semester
- Master Computer Science 2012 (optional subject), specialization field medical informatics, 3rd semester
- Bachelor Medical Informatics 2011 (optional subject), medical computer science, 4th to 6th semester
- Bachelor MES 2011 (optional subject), life sciences, 3rd or 5th semester
- Bachelor CLS 2010 (compulsory), mathematics, 3rd or 5th semester

Classes and lectures:

- Clinical Studies (lecture, 2 SWS)
- Clinical Studies (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Definition of a clinical study according to the German Drug Law, classification of clinical studies, clinical development
- Basic principles of clinical trials and measures against bias
- Regulations and study documents
- Development of a clinical study, especially a study protocol
- Contents of a study protocol
- Link to health economics
- Further topics like
- Special study designs
- Advanced statistical analyses
- Report and publication
- Systematic overview and meta-analyses
- Data management and system validation
- Professional fields in clinical studies (study statistics, data management, monitoring, quality management, pharmacovigilance, project management)

Qualification-goals/Competencies:

- Students can describe the regulatory framework of clinical trials with drugs.
- They can describe the main areas of activity in the fields of study statistics, data management, monitoring, information technology and quality assurance.
- They can explain the basic principles of clinical trials and measures to achieve these basic principles.
- They can create a study protocol.
- They can represent study populations descriptively.
- They can perform case number planning for simple clinical studies.
- Students can assign studies and their key points to the stages of clinical development.
- They can explain different study designs.
- They are informed about ethical problems and guidelines and the principles of data protection.
- Acquisition of german and english technical language

Grading through:

- portfolio exam

Requires:

- Biostatistics 1 (MA1600-KP04, MA1600, MA1600-MML)

Responsible for this module:

- PD Dr. rer. pol. Reinhard Vonthein
- Prof. Dr. rer. biol. hum. Inke König

Teacher:

- Institute of Medical Biometry and Statistics

- PD Dr. rer. pol. Reinhard Vonthein
- Prof. Dr. rer. biol. hum. Inke König

Literature:

- Gaus W., Chase D.: Klinische Studien: Regelwerke, Strukturen, Dokumente und Daten - Norderstedt: Books on Demand GmbH 2007 (2. Auflage)
- Stapff M.: Arzneimittelstudien - Eine Einführung in klinische Prüfungen für Ärzte, Studenten, medizinisches Assistenzpersonal und interessierte Laien - Germering/München: W. Zuckschwerdt Verlag GmbH 2008 (5. Auflage)
- Schumacher, M., Schulgen, G.: Methodik klinischer Studien: Methodische Grundlagen der Planung, Durchführung und Auswertung - Berlin: Springer 2008 (3. Auflage)

Language:

- German and English skills required

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):
- None

Module exam(s):
- MA2214-L1: Clinical Studies, portfolio exam, 100 % of module grade, with a total of 200 points, distributed as follows:
+ 145 points for project work with documentation and presentations
+ 55 points for 5 short term papers

The course is held annually in German and English alternately. Languages Englisch or German may be chosen for homework and project with
documentation and presentation.

MA3400-KP04, MA3400 - Biomathematics (Biomathe)

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

Course of study, specific field and term:

- Master Molecular Life Science 2023 (optional subject), mathematics / computer science, 1st 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 2014 (optional subject), medical computer science, 5th or 6th semester
- Bachelor MES 2014 (optional subject), mathematics / natural sciences, 3rd or 5th semester
- Bachelor Computer Science 2014 (compulsory), specialization field bioinformatics, 5th semester
- Master MES 2011 (optional subject), mathematics, 1st semester
- Bachelor Medical Informatics 2011 (optional subject), bioinformatics, 4th to 6th semester
- Master Computer Science 2012 (optional subject), specialization field medical informatics, 3rd semester
- Bachelor MES 2011 (optional subject), mathematics, 5th semester
- Bachelor Computer Science 2012 (compulsory), specialization field bioinformatics, 5th semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

- Examples and elementary solution methods for ordinary differential equations
- Existence and uniqueness theorems
- Dependence of solutions on initial conditions
- Linear systems (in particular with constant coefficients)
- Higher-Order linear differential equations
- Qualitative theory of nonlinear systems
- In accordance to the rules of GSP of UzL

Qualification-goals/Competencies:

- Students are able to explain basic notions from the theory of ordinarydifferential equations.
- Based on examples, students are able to explain
- Based on theorems, students are able to give conditions under which
- Students are able to find explicit solutions of simple differential equations.
- Students are able to explain how solutions of differential equations can beanalysed qualitatively.
- Students are able to present important models of the natural sciences which canbe analysed by differential equations.

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:

- PD Dr. rer. nat. Christian Bey

Teacher:

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

Literature:

- G. Birkhoff, G.-C. Rota: Ordinary Differential Equations

- H. Heuser: Gewöhnliche Differentialgleichungen - Teubner Verlag 2009 (6. Auflage)
- M.W. Hirsch, S. Smale: Differential Equations, Dynamical Systems, and Linear Algebra
- J. D. Murray: Mathematical Biology - Springer
- J. Scheurle: Gewöhnliche Differentialgleichungen
- R. Schuster: Biomathematik - Vieweg + Teubner Studienbücher 2009
- W. Walter: Gewöhnliche Differentialgleichungen

Language:

- offered only in German

Notes:

Prerequisites for the module:
- nothing

Prerequisites for admission to the written examination:
- Successful completion of homework assignments during the semester

Module exam:
- MA3400-L1: Biomathematik, written exam, 90 min, 100 % 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

CS3310 - Image and Signal Processing in Medicine 1 (MBS)

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

Course of study, specific field and term:

- Bachelor MES 2011 (compulsory), medical engineering science, 5th semester
- Bachelor Medical Informatics 2011 (compulsory), medical computer science, 5th semester

Classes and lectures:

- Image and signal processing in medicine 1 (lecture, 2 SWS)
- Image and signal processing in medicine 1 (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Motivation, principles and applications of medical image and signal processing
- Signal processing in electrocardiography (ECG)
- Signal processing in the electroencephalogram (EEG)
- Structure and formats of medical images
- Fundamentals of pattern recognition (segmentation, feature extraction, classification, interpretation)
- Histograms and image transformations
- Image filtering with local operators
- Segmentation: thresholding, region growing
- Morphological operators
- Application and evaluation of segmentation methods
- Basic methods for the visualization of medical images and image sequences
- Basic methods of image registration: rigid image registration
- Combined signal and image analysis in functional MRI
- Application examples

Qualification-goals/Competencies:

- Basic knowledge of methods and procedures of medical image processing
- Ability to evaluate and apply the application methods and algorithms in the respective phase of image processing pipelines
- Overview of the scope of medical image processing by many examples
- Capacity for communication and processing of medical image data
- Knowledge of methods for combined analysis of signal and image sequences in medicine

Grading through:

- written exam

Is requisite for:

- Image and Signal Processing in Medicine 2 (CS3810)

Responsible for this module:

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

Teacher:

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

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

CS3330 - Practical Medical Informatics (ProjMI)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	8 (Typ B)

Course of study, specific field and term:

- Bachelor Medical Informatics 2011 (compulsory), medical computer science, 5th semester

Classes and lectures:

- Projektpraktikum Medizinische Informatik (team work, 6 SWS)

Workload:

- 110 Hours work on project
- 90 Hours group work
- 30 Hours written report
- 10 Hours oral presentation (including preparation)

Contents of teaching:

- Introduction to required methods and software tools, relevant to the project
- Planning and execution of a software /hardware project, from requirements analysis to productive use. Self-organization and working in efficient teams in compliance with standards and deadlines.
- The project is separated into sub-projects with topics chosen from both eHealth and medical imaging fields.

Qualification-goals/Competencies:

- Enhancing practical knowledge and skills in software development in the areas of e-Health and medicalimage processing.
- Acquisition of skills for the use of software tools and practical implementation of medical standards for the processing of medical data.
- Ability to identify and phrase the requirements for a software system under discussion with target groups.
- Ability to analyze complex problems, to be divided into sub-tasks and implement in an efficient implementation.
- Ability to estimate the project effort, plan the project schedule and use resources purposeful.
- Ability to integrate and merge sub-parts to the overall solution and to ensure the quality.
- Ability to document the work and source code and to present results.

Grading through:

- successful addressing of the project goals

Requires:

- Databases (CS2700-KP04, CS2700)
- Algorithms and Data Structures (CS1001-KP08, CS1001)
- Software Engineering I (CS2300)
- Programming (CS1000)
- Informatics in Health Care - eHealth (CS3300-MI)
- 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
- Prof. Dr. rer. nat. habil. Josef Ingenerf

Language:

- offered only in German

CS3703-KP04, CS3703 - Bachelor Seminar Medical Informatics (BachSemMI)

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

Course of study, specific field and term:

- Bachelor Medical Informatics 2019 (compulsory), interdisciplinary competence, 5th semester
- Bachelor Medical Informatics 2014 (compulsory), interdisciplinary competence, 5th semester
- Bachelor Medical Informatics 2011 (compulsory), interdisciplinary competence, 5th semester

Classes and lectures:

- Seminar (seminar, 2 SWS)

Workload:

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

Contents of teaching:

- Training in a scientific topic
- Processing a scientific problem and its solution methods
- Presentation and discussion of the topic in English

Qualification-goals/Competencies:

- The students are able to analyze, judge and develop a scientific topic.
- They are able to present the results in a written documentation and in a talk in an scientific way
- The are able to present and discuss a scientific topic in English.
- They are able to classify and differentiate the topic in the wider academic context.
- They improve their language competency.

Grading through:

- oral presentation
- term paper

Responsible for this module:

- Studiengangsleitung Medizinische Informatik

Teacher:

- Institute of Medical Informatics

Literature:

- Subject and literature are determined individually:
- Participants should have the task in a timely manner, i. At least 1 MONTH before the beginning of the event, discuss with the lecturer:

Language:

- offered only in English

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful participation in the seminar incl. elaboration, presentation, contributions to the discussion according to the requirements at the beginning of the semester.

Module Exam(s):
- CS3703-L1: Bachelor Seminar Medical Informatics, seminar, ungraded

ME3000 - Medical Imaging, Image and Signal Computing (MEDBGBV)

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

Course of study, specific field and term:

- Bachelor MES 2011 (compulsory), medical engineering science, 5th semester
- Bachelor Medical Informatics 2011 (compulsory), medical computer science, 5th semester

Classes and lectures:

- Module part CS3310: Image and Signal Processing in Medicine 1 (course, 3 SWS)
- Module part ME3100: Medical Imaging (course, 3 SWS)

Workload:

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

Contents of teaching:

- See description of module parts

Qualification-goals/Competencies:

- See description of module parts

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. rer. nat. Thorsten Buzug

Teacher:

- Institute of Medical Engineering
- Institute of Medical Informatics

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

Language:

- German and English skills required

ME3100 - Medical Imaging (MBG)

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

Course of study, specific field and term:

- Bachelor MES 2011 (compulsory), medical engineering science, 5th semester
- Bachelor Medical Informatics 2011 (compulsory), medical computer science, 5th semester

Classes and lectures:

- Medical Imaging (lecture, 2 SWS)
- Medical Imaging (practical course, 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

PS3700 - Presentation and Documentation (PundD)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	3 (Typ B)

Course of study, specific field and term:

- Bachelor Medical Informatics 2011 (compulsory), interdisciplinary competence, 5th semester
- Bachelor Computer Science 2012 (compulsory), interdisciplinary competence, 5th semester

Classes and lectures:

- Presentation and documentation (exercise, 2 SWS)

Workload:

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

Contents of teaching:

- Techniques of scientific investigation
- Techniques of scientific writing
- Bibliographical reference and citations in scientific papers
- Desktop publishing: LaTeX, OpenOffice, MS Word
- Structuring of Talks
- Skills for talks
- LaTeX, Impress, and Powerpoint presentations - Do's and don'ts

Qualification-goals/Competencies:

- The Students know about the most important presentation technologies
- They obtained some insight into technologies about scientific writing and documentation
- They are able to apply their skills in talks and in writing scientific papers

Grading through:

- participation in discussions

Responsible for this module:

- PD Dr. Gerhard Buntrock

Teacher:

- Institute for Theoretical Computer Science
- Institute of Software Technology and Programming Languages

- PD Dr. Gerhard Buntrock
- Prof. Dr. rer. nat. Till Tantau
- Prof. Dr. rer. nat. Amir Madany Mamlouk

Literature:

- Matthias Karmasin, Rainer Ribing: Die Gestaltung wissenschaftlicher Arbeiten - UTB 2011

Language:

- offered only in German

CS3203 - Image processing (Bildverarb)

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

Course of study, specific field and term:

- Bachelor Computer Science 2012 (optional subject), specialization field bioinformatics, 6th semester
- Bachelor Medical Informatics 2011 (compulsory), computer science, 6th semester
- Master CLS 2010 (compulsory), mathematics, 2nd semester
- Bachelor Computer Science 2012 (compulsory), specialization field robotics and automation, 6th semester
- Bachelor Computer Science 2012 (optional subject), central topics of computer science, 5th or 6th semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

- Introduction, interest of visual information
- Fourier transformation
- Sampling and sampling theorem
- Filtering
- Image enhancement
- Edge detection
- Multiresolution concepts: Gaussian and Laplacian Pyramid, wavelets
- Principles of image compression
- Segmentation
- Morphological image processing

Qualification-goals/Competencies:

- Students 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 or oral exam as announced by the examiner

Requires:

- Signal processing (CS3100-KP04)
- Analysis 1 (MA2000-KP08, MA2000)

Responsible for this module:

- Prof. Dr.-Ing. Alfred Mertins

Teacher:

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

Literature:

- 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

CS3800-KP03, CS3800 - Social Aspects of Medical Informatics (GesellMI)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	3 (Typ B)

Course of study, specific field and term:

- Bachelor Medical Informatics 2019 (compulsory), interdisciplinary competence, 6th semester
- Bachelor Medical Informatics 2014 (compulsory), interdisciplinary competence, 6th semester
- Bachelor Medical Informatics 2011 (compulsory), interdisciplinary competence, 6th semester

Classes and lectures:

- Social Aspects of Medical Informatics (lecture, 1 SWS)
- Social Aspects of Medical Informatics (seminar, 1 SWS)

Workload:

- 40 Hours written report
- 30 Hours in-classroom work
- 20 Hours private studies

Contents of teaching:

- History and philosophy of technology and informatics in general
- Theories of technolution (how and when do innovations emerge?)
- Critique and assessment of technology, technology assessment
- Fields of application of information technology in medicine
- Ethical and societal aspects of information technology
- Data security, cultural and aesthetical aspects of digital media

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 medical informatics.
- They are capable to identify questions of social acceptability of information technology, to carve out their different implications, and to discuss them critically.
- They have an understanding of the philosophical and cultural implications of information technology, and are able to apply this knowledge to case studies.
- 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 oral and written form.

Grading through:

- presentation
- Written report
- continuous, successful participation in course

Responsible for this module:

- Prof. Dr. med. Cornelius Borck

Teacher:

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

- Prof. Dr. med. Cornelius Borck
- Prof. Dr. rer. nat. Burghard Weiss
- Prof. Dr. rer. nat. habil. Heinz Handels
- Prof. Dr. phil. Christoph Rehmann-Sutter
- Dipl.-Inform. Dr. med. Jan-Hinrich Wrage
- Dr. phil. nat. Thorsten Kohl
- Dr. phil. Daniela Zetti

Literature:

- Kramme R (Hrsg.): Medizintechnik: Verfahren Systeme Informationsverarbeitung - 4. Aufl. Berlin, Heidelberg, New York: Springer 2011
- Orland B (Hrsg): Artifizielle Körper lebendige Technik: Technische Modellierungen des Körpers in historischer Perspektive - Zürich: Chronos 2005
- Horx M: Technolution. Wie unsere Zukunft sich entwickelt - Frankfurt: Campus 2008

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful and regular participation in the seminar incl. elaboration, presentation, contributions to the discussion as specified at the beginning of the semester.

Module Exam(s):
- CS3800-L1: Social Aspects of Medical Informatics, ungraded seminar

CS3991-KP15, CS3991 - Bachelor Thesis Medical Informatics (BScMI)

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

Course of study, specific field and term:

- Bachelor Medical Informatics 2019 (compulsory), medical computer science, 6th semester
- Bachelor Medical Informatics 2014 (compulsory), medical computer science, 6th semester
- Bachelor Medical Informatics 2011 (compulsory), medical computer science, 6th semester

Classes and lectures:

- Bachelor Thesis Medical Informatics (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:

- Independent scientific work on a limited task of medical informatisc and its applications
- Scientific presentation about the problem and the solution developed

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
- colloquium

Responsible for this module:

- Studiengangsleitung Medizinische Informatik

Teacher:

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

Literature:

- :

Language:

- thesis can be written in German or English

Notes:

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

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

Module Exam(s):
- CS3991-L1: Bachelor thesis with colloquium, 100% of the module grade.

Of the credit points of the module, 12 credit points are awarded for the actual thesis, the remaining credit points for the preparation and execution of the colloquium.

MZ3160 - Radiologie, Nuklearmedizin, Strahlentherapie (RNS)

Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	3

Course of study, specific field and term:

- Bachelor Medical Informatics 2011 (compulsory), medical computer science, 6th semester
- Bachelor MES 2011 (compulsory), medicine, 6th semester

Classes and lectures:

- Radiology, Nuclearmedicine, Radiotherapy (lecture, 2 SWS)

Workload:

- 30 Hours in-classroom work
- 20 Hours exam preparation
- 20 Hours group work
- 20 Hours private studies

Contents of teaching:

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-

Qualification-goals/Competencies:

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-
-

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. med. Jörg Barkhausen

Teacher:

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- Prof. Dr. med. Jörg Barkhausen
- PD Dr. Florian Vogt
- PD Dr. Peter Hunold
- Prof. Dr. Beate Stöckelhuber
- Dr. Christian Mohr
- Prof. Dr. med. Peter Schramm
- Dr. Lutz Schelper
- Prof. Dr. med. Jürgen Dunst
- PD Dr. med. Inga Buchmann
- PD Dr. med. Dirk Rades
- Dr. Corinna Melchert
- M. Sc. Markus Dahlke

Literature:

- :
- :
- :

- :

Language:

- offered only in German