UNIVERSITÄT ZU LÜBECK

Module Guide for the Study Path

Master Entrepreneurship in Digital Technologies 2014

Version from 1. October 2025

interdisciplinary competence

Applied computer science

technology field computer science

entrepreneurship

mathematics / natural sciences

Module part

specific

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

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

Course of study, specific field and term:

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

Classes and lectures:

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

Workload:

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

Contents of teaching:

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

Qualification-goals/Competencies:

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

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. phil. André Calero Valdez

Teacher:

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

Literature:

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

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

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

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

EC4010-KP04, EC4010 - Commercial Law (WirtRecht)

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

Course of study, specific field and term:

- Master Computer Science 2019 (optional subject), interdisciplinary competence, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (optional subject), interdisciplinary competence, Arbitrary semester
- Master Medical Informatics 2019 (optional subject), interdisciplinary competence, 1st or 2nd semester
- Master Interdisciplinary Courses (optional subject), Interdisciplinary modules, Arbitrary semester
- Master MES 2014 (optional subject), no specific field, Arbitrary semester
- Bachelor MES 2014 (optional subject), no specific field, 3rd semester at the earliest
- Master Medical Informatics 2014 (optional subject), interdisciplinary competence, 1st or 2nd semester
- Master Computer Science 2014 (optional subject), interdisciplinary competence, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (optional subject), interdisciplinary competence, Arbitrary semester

Classes and lectures:

- Commercial Law (lecture, 2 SWS)
- Commercial Law (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- The importance of legal aspects in entrepreneurship especially in the high-tech sector
- legal acts
- contract law
- technology protection and intellectual property (know how, patents, trademarks, designs, with license rights)
- labor law
- corporate law
- enforcement of legal claims

Qualification-goals/Competencies:

- The objective of the course is to provide students with a basic knowledge of legal subjects relevant for scientists, medical doctors, engineers and computer scientists in technology-driven enterprises or in research at a university.
- Students will gain an understanding of legal reasoning to help them avoid pitfalls and exploit to the fullest extent opportunities in R&D projects and startup companies.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. Christian Scheiner

Teacher:

- Institute for Entrepreneurship and Business Development
- Dr. Carsten Richter

Literature:

- Carsten Richter: Kurshandout - -
- Ann/Hauck/Obergfell: Wirtschaftsrecht kompakt - München 2012
- Meyer: Wirtschaftsprivatrecht - Heidelberg 2012
- -: BGB Bürgerliches Gesetzbuch - Beck-Texte, neuste Auflage
- Schönfelder: Deutsche Gesetze Textsammlung - neuste Auflage

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- none

Prerequisites for participation in module exam(s):
- none
- Prerequisites for admission to the (written) examination may be scheduled at the beginning of the semester. When prerequisites are defined, they should be completed and positively evaluated before the initial (written) examination.

Module exam(s):
- EC4010-L1: Commercial Law, written exam, 60 min, 100 % of module grade

EC5003-KP04 - Research seminar EdT (FSEdT)

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

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (optional subject), interdisciplinary competence, 3rd semester
- Master Entrepreneurship in Digital Technologies 2014 (optional subject), interdisciplinary competence, 3rd semester

Classes and lectures:

- EC5003-V: Research seminar EdT (lecture, 1 SWS)
- EC5003-Ü: Research seminar EdT (exercise, 1 SWS)

Workload:

- 90 Hours work on project
- 30 Hours in-classroom work

Contents of teaching:

- The subjects of this course are Entrepreneurship und Innovation Management.
- Within the framework of this seminar, students develop and carry out a scientific research project, as far as possible independently.
- For this purpose the students evaluate, question and compare scientific articles and publications written in English and German, which they have to search for themselves and from which they draw their own conclusions.
- Based on this research, students form and substantiate hypotheses or research questions. These are checked, assessed, discussed, and interpreted on the basis of the students own qualitative or quantitative survey.
- For this purpose, the students work on a given research area from the research fields mentioned above.
- The research seminar is the obligatory prerequisite for working on a master thesis at the Institute for Entrepreneurship & Business Development for students of the course

Qualification-goals/Competencies:

- The students gain an insight into scientific work.
- The students learn in the seminar to assess their own strengths and weaknesses with regard to their scientific work.
- They are able to work on new research-oriented tasks in the treated or other research disciplines and to identify, evaluate and implement research topics based on the scientific literature.
- The students are able to give other students appreciative feedback on their intermediate achievements.
- The students learn and work together with other students on individual tasks of the seminar, and in the team, they take on an outstanding responsibility.

Grading through:

- portfolio exam

Is requisite for:

- Master Thesis Entrepreneurship in digital Technologies (EC5500-KP30, EC5500)

Responsible for this module:

- Prof. Dr. Christian Scheiner

Teacher:

- Institute for Entrepreneurship and Business Development
- Prof. Dr. Christian Scheiner
- Dr. Stefan Becker

Literature:

- Current course-specific literature per semester:

Language:

- German and English skills required

Notes:

Prerequisites for attending the module:
- none

Prerequisites for participation in module exam(s):
- none

Module exam(s):
- Portfolio exam consisting of presentation and written assignment, 100% of module grade

PS5810-KP04, PS5810 - Scientific Teaching and Tutoring (WLehrKP04)

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

Course of study, specific field and term:

- Bachelor Interdisciplinary Courses for health sciences (optional subject), interdisciplinary competence, Arbitrary semester
- Master Computer Science 2019 (optional subject), interdisciplinary competence, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (optional subject), interdisciplinary competence, Arbitrary semester
- Master Interdisciplinary Courses (optional subject), Interdisciplinary modules, Arbitrary semester
- Bachelor Interdisciplinary Courses (optional subject), Interdisciplinary modules, Arbitrary semester
- Master CLS 2016 (optional subject), Interdisciplinary modules, 3rd semester
- Master Entrepreneurship in Digital Technologies 2014 (optional subject), interdisciplinary competence, Arbitrary semester
- Master Media Informatics 2014 (optional subject), interdisciplinary competence, Arbitrary semester
- Master MES 2014 (optional subject), no specific field, 1st or 2nd semester
- Bachelor MES 2014 (optional subject), no specific field, Arbitrary semester
- Master Computer Science 2014 (optional subject), interdisciplinary competence, Arbitrary semester
- Master CLS 2010 (optional suject), interdisciplinary competence, 3rd semester
- Master Computer Science 2012 (optional subject), interdisciplinary competence, Arbitrary semester

Classes and lectures:

- Theory and Practice of Good Teaching (seminar, 1 SWS)
- Work as a tutor in a lecture (practical course, 2 SWS)

Workload:

- 60 Hours private studies and exercises
- 45 Hours oral presentation (including preparation)
- 15 Hours in-classroom work

Contents of teaching:

- Organizing and running a scientific lecture
- Basic didactics of scientific teaching
- Practical work in tutorials

Qualification-goals/Competencies:

- The participants are able to lead a student working group and to communicate technical issues to it appropriately.
- Basic pedagogical and didactical skills

Grading through:

- continuous participation in all courses of the module

Responsible for this module:

- Prof. Dr. rer. nat. Nico Bunzeck
- Prof. Dr. rer. nat. Jürgen Prestin

Teacher:

- Institute for Mathematics
- PD Dr. rer. nat. Jörn Schnieder
- Alle prüfungsberechtigten Dozentinnen/Dozenten des Studienganges
- Corinna Lütsch

Language:

- depends on the chosen courses

Notes:

The seminar must be attended before working as a tutor. This activity cannot be remunerated.

The course instructor in charge of the respective course will issue a certificate of achievement for the module.

PY1710-KP04, PY1710 - Work Psychology (ArbPsy)

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

Course of study, specific field and term:

- Bachelor Media Informatics 2014 (compulsory), interdisciplinary competence, 2nd semester
- Bachelor Psychology 2013 (optional subject), psychology, Arbitrary semester
- Bachelor Psychology 2016 (optional subject), psychology, 2nd or 4th semester
- Master Entrepreneurship in Digital Technologies 2014 (optional subject), interdisciplinary competence, Arbitrary semester

Classes and lectures:

- Work Psychology (lecture, 2 SWS)
- Work Psychology (seminar, 1 SWS)

Workload:

- 75 Hours private studies and exercises
- 45 Hours in-classroom work

Contents of teaching:

- History of work psychology
- Sociotechnical systems and work systems
- Models of work behavior
- Work analysis and evaluation
- Effects of work
- Designing work environments and tasks
- Human-machine-systems within work systems
- Training and skill development
- Work motivation and satisfaction with work

Qualification-goals/Competencies:

- The students can denote components and influential factors in work systems that include human-machine-interaction and can explain them with recourse to models especially for computer workstations and other applications of digital media in work systems.
- They are able to use psychological concepts and methods and can read and understand psychological scientific studies on applications of digital and interactive media in the context of work.
- They can cooperate effectively with psychologists and ergonomists in interdisciplinary teams.

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. Thomas Franke

Teacher:

- Institute for Multimedia and Interactive Systems
- Prof. Dr. rer. nat. Thomas Franke

Literature:

- F. W. Nerdinger, G. Blickle & N. Schaper: Arbeits- und Organisationspsychologie (3. Auflage) - Berlin, Heidelberg: Springer, 2014
- K. Sonntag, E. Frieling & R. Stegmaier: Lehrbuch Arbeitspsychologie (3. Auflage) - Bern: Hans Huber, 2012

Language:

- offered only in German

Notes:

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

The module will be offered for the last time in the summer semester 2020.

PY5210-KP04, PY5210 - Motivational and Emotional Psychology (MotivPsy)

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

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2014 (optional subject), interdisciplinary competence, 1st or 3rd semester
- Master Media Informatics 2014 (compulsory), psychology, 3rd semester

Classes and lectures:

- Motivational and Emotional Psychology (lecture, 2 SWS)
- Motivational and Emotional Psychology (seminar, 1 SWS)

Workload:

- 75 Hours private studies and exercises
- 45 Hours in-classroom work

Contents of teaching:

- History of motivation and emotion psychology
- Methods in motivation and emotion psychology
- Implicit and explicit motives
- Approach and avoidance
- Intrinsic motivation
- Goals, volition, and action control
- Classifications of emotions
- Emotion theories
- Development of emotions
- Emotion regulation

Qualification-goals/Competencies:

- The students are able to reproduce the basics of theories about motivational processes and to sketch different emotion theories in comparison.
- They are able to trace the effects and the dynamics of motivation in interacting with technical systems and in using media.
- They can judge and classify emotional processes in the use of technical systems and media and know about methods for measuring emotional reactions.

Grading through:

- written exam
- portfolio exam

Responsible for this module:

- Prof. Dr. rer. nat. Thomas Franke

Teacher:

- Institute for Multimedia and Interactive Systems
- Prof. Dr. rer. nat. Thomas Franke

Literature:

- V. Brandstätter, J. Schüler, R. M. Puck & L. Lozo: Motivation und Emotion - Heidelberg: Springer, 2013
- K. Rothermund & A. Eder: Motivation und Emotion - Wiesbaden: VS Verlag, 2012

Language:

- offered only in German

CS4130-KP06, CS4130 - Information Systems (InfoSys)

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

Course of study, specific field and term:

- Master Computer Science 2019 (compulsory), Canonical Specialization Data Science and AI, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (basic module), Applied computer science, 1st or 2nd semester
- Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester
- Master Computer Science 2019 (basic module), Applied computer science, 1st or 2nd semester
- Master Medical Informatics 2019 (basic module), Applied computer science, 1st or 2nd semester
- Master Robotics and Autonomous Systems 2019 (optional subject), Elective, 1st or 2nd semester
- Master IT-Security 2019 (basic module), Applied computer science, 1st or 2nd semester
- Master Medical Informatics 2014 (basic module), ehealth / infomatics, 1st or 2nd semester
- Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (basic module), Applied computer science, 1st or 2nd semester
- Master Computer Science 2014 (optional subject), specialization field software systems engineering, 2nd or 3rd semester
- Master Computer Science 2014 (basic module), Applied computer science, 1st or 2nd semester

Classes and lectures:

- Information Systems (lecture, 2 SWS)
- Information Systems (exercise, 2 SWS)

Workload:

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

Contents of teaching:

- Motivation of knowledge graphs and their relationship to the Semantic Web
- Overview over the W3C Semantic Web family of languages
- Comparison between and the interaction of knowledge graphs and generative artificial intelligence such as large language models
- Graph Neural Networks and their applications for tasks of knowledge graphs

Qualification-goals/Competencies:

- Knowledge: Students acquire an overview of knowledge graphs and the Semantic Web as well as generative artificial intelligence such as large language models and graph neural networks.
- Skills: Students can assess the possibilities and limitations of knowledge graphs and the Semantic Web. They can estimate the consequences of the Semantic Web approach for data modeling, data administration and processing and for applications. They can develop Semantic Web applications. They can use generative artificial intelligence such as large language models and graph neural networks to solve tasks for and in addition to knowledge graphs. They can discuss open research questions in the area of knowledge graphs and the semantic web as well as in comparison to generative artificial intelligence and graph neural networks.
- Social skills and independence: Students work in groups to complete exercises and small projects. Students' independent practical work is encouraged through exercises, some of them directly on the computer.

Grading through:

- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr. Sven Groppe

Teacher:

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

Literature:

- M. Kejriwal, C. Knoblock: Knowledge graphs - MIT Press, 2021
- S. Groppe: Data Management and Query Processing in Semantic Web Databases - Springer, 2011
- W. L. Hamilton: Graph Representation Learning. In Synthesis Lectures on Artificial Intelligence and Machine Learning - Springer International Publishing, 2020
- D. Jurafsky, J. H. Martin: Speech and language processing - Upper Saddle River, NJ: Pearson, 2008
- D. Foster: Generative deep learning - Sebastopol, CA: O Reilly Media, 2023

Language:

- German and English skills required

Notes:

Admission requirements for taking the module:
- None

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

Module Exam(s):
- CS4130-L1: Information Systems, written exam or oral exam, 100% of module grade

Previous name: Web Based Information Systems

CS4150-KP06, CS4150SJ14 - Distributed Systems (VertSys14)

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

Course of study, specific field and term:

- Master Computer Science 2019 (compulsory), Canonical Specialization SSE, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (basic module), Applied computer science, 1st or 2nd semester
- Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester
- Master Computer Science 2019 (basic module), Applied computer science, 1st or 2nd semester
- Master Medical Informatics 2019 (basic module), Applied computer science, 1st or 2nd semester
- Master Robotics and Autonomous Systems 2019 (optional subject), Elective, 1st or 2nd semester
- Master IT-Security 2019 (basic module), Applied computer science, 1st or 2nd semester
- Master Medical Informatics 2014 (basic module), ehealth / infomatics, 1st or 2nd semester
- Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (basic module), Applied computer science, 1st or 2nd semester
- Master Computer Science 2014 (optional subject), specialization field software systems engineering, 2nd or 3rd semester
- Master Computer Science 2014 (basic module), Applied computer science, 1st or 2nd semester

Classes and lectures:

- Distributed Systems (lecture, 2 SWS)
- Distributed Systems (exercise, 2 SWS)

Workload:

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

Contents of teaching:

- Introduction and motivation
- Protocols and layered models
- Message representations
- Realization of network services
- Communication mechanisms
- Addresses, names and directory services
- Synchronisation
- Replication and consistency
- Fault tolerance
- Distributed transactions
- Security

Qualification-goals/Competencies:

- The participants will accquire a deep understanding for problems to be solved in distributed systems, such as synchronization, error handling, naming etc.
- They know the most important services in distributed systems such as name service, distributed file systems etc.
- They are able to program simple distributed applications and systems themselves.
- They know the most important algorithms in distributed systems, for instance for time synchronization, for leader election, or for mutual exclsuion.
- They have a good feeling for when it makes sense to use distributed instead of centralized systems.
- They have a good feeling for what kind of solutions could best be used for what kind of problems in distributed Internet applications.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. Stefan Fischer

Teacher:

- Institute of Telematics

- Prof. Dr. Stefan Fischer
- Dr. rer. nat. Florian-Lennert Lau

Literature:

- A. Tanenbaum, M. van Steen: Distributed Systems: Principles and Paradigms - Prentice Hall 2006
- G. Coulouris, J. Dollimore, T. Kindberg, G. Blair: Distributed Systems - Concepts and Design - Addison Wesley 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):
- CS4150-L1 Distributed Systems, written exam, 90min, 100% of module grade.

CS4000-KP06, CS4000SJ14 - Algorithmics (ALG14)

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

Course of study, specific field and term:

- Master Computer Science 2019 (compulsory), Canonical Specialization Data Science and AI, Arbitrary semester
- Master Computer Science 2019 (compulsory), Canonical Specialization Bioinformatics and Systems Biology, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master Computer Science 2019 (basic module), Theoretical computer science, 1st or 2nd semester
- Master Medical Informatics 2019 (optional subject), Theoretical computer science, 1st or 2nd semester
- Master IT-Security 2019 (compulsory), Theoretical computer science, 1st or 2nd semester
- Master Medical Informatics 2014 (basic module), computer science, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (basic module), technology field computer science, 1st or 2nd semester
- Master Computer Science 2014 (optional subject), specialization field IT security and safety, 2nd or 3rd semester
- Master Computer Science 2014 (basic module), Theoretical computer science, 1st or 2nd semester

Classes and lectures:

- Algorithmics (lecture, 2 SWS)
- Algorithmics (exercise, 2 SWS)

Workload:

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

Contents of teaching:

- complexity analysis of algorithmic problems
- discrete optimization problems, linear programming
- satisfiability and constraint satisfaction problems
- randomized algorithms
- approximation algorithms and heuristics
- algorithms for algebraic problems

Qualification-goals/Competencies:

- The students can model real problems in an algorithmic manner.
- They can apply basic algorithmic techniques with full command.
- They can analyze algorithms, in particular with respect to corrrectness and complexity.
- They can design efficient algorithms for complex problems.

Grading through:

- written exam

Requires:

- Theoretical Computer Science (CS2000-KP08, CS2000)
- Algorithm Design (CS3000-KP04, CS3000)

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:

- Aho, Hopcroft, Ullman: Design and Analysis of Computer Algorithms - Addison Wesley, 1978
- Cormen, Leiserson, Rivest, Stein: Introduction to Algorithms - The MIT Press, 2009
- Mitzenmacher, Upfal: Probability and Computing - Cambridge University Press, 2005
- Kreher, Stinson: Combinatorial Algorithms - CRC Press, 1999
- Williamson, Shmoys: The Design of Approximation Algorithms - Cambridge University Press, 2011

Language:

- German and English skills required

Notes:

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

CS4020-KP06, CS4020SJ14 - Specification and Modelling (SpezMod14)

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

Course of study, specific field and term:

- Master Media Informatics 2020 (optional subject), computer science, 3rd semester
- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master Computer Science 2019 (basic module), Theoretical computer science, 1st or 2nd semester
- Master Medical Informatics 2019 (optional subject), Theoretical computer science, 1st or 2nd semester
- Master IT-Security 2019 (compulsory), Theoretical computer science, 1st or 2nd semester
- Master Medical Informatics 2014 (basic module), computer science, 1st or 2nd semester
- Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (basic module), technology field computer science, 1st or 2nd semester
- Master Computer Science 2014 (optional subject), specialization field IT security and safety, 2nd or 3rd semester
- Master Computer Science 2014 (basic module), Theoretical computer science, 1st or 2nd semester

Classes and lectures:

- Specification and Modelling (lecture, 2 SWS)
- Specification and Modelling (exercise, 2 SWS)

Workload:

- 80 Hours private studies and exercises
- 60 Hours in-classroom work
- 20 Hours exam preparation
- 20 Hours work on project

Contents of teaching:

- Introduction to modelling and specification
- Modelling concepts (data, streams, traces, diagrams, tables)
- Modelling software components (state, behaviour, structure, interface)
- Modelling concurrency
- Algebraic specification
- Composing, refining, analysing and transforming specifications and models
- Specification languages and tools for specification and modelling

Qualification-goals/Competencies:

- The students can argue on the importance of specifications and models for software development.
- They can characterize, apply, adapt and extent important specification and modelling techniques.
- They can model and specify simple software/hardware system in an adequate way.
- They can describe a system from different views and on different levels of abstraction.
- They can apply specifications and modelsin software development.
- They can analyse specifications and models.

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
- Dr. Annette Stümpel
- Prof. Dr. Martin Leucker

Literature:

- V.S. Alagar, K. Periyasamy: Specification of Software Systems - Springer 2013
- M. Broy, K. Stølen: Specification and Development of Interactive Systems - Springer 2001
- J. Loeckx, H.-D. Ehrich, M. Wolf: Specification of Abstract Data Types - John Wiley & Sons 1997
- D. Bjorner: Software Enginneering 1-3 - Springer 2006
- U. Kastens, H. Kleine Büning: Modellierung - Grundlagen und formale Methoden - Hanser 2005

Language:

- German and English skills required

Notes:

Admission requirements for taking the module:
- None

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

Module Examination(s):
- CS4020-L1: Specification and Modeling, written exam, 90min, 100% of the module grade.

CS4502-KP12, CS4502 - Parallel and distributed systems (PVS14)

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

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2014 (advanced module), technology field computer science, 2nd and/or 3rd semester
- Master Computer Science 2014 (advanced module), advanced curriculum, 2nd and/or 3rd semester

Classes and lectures:

- Parallel Computing, see CS3051 T (lecture, 2 SWS)
- Parallel Computing (exercise, 1 SWS)
- Architectures for distributed applications (lecture, 3 SWS)
- Seminar Parallel and Distributed Systems (seminar, 2 SWS)

Workload:

- 140 Hours private studies and exercises
- 120 Hours in-classroom work
- 60 Hours work on project
- 40 Hours exam preparation

Contents of teaching:

- Architectures of parallel and distributed systems
- Programming language support for parallel algorithms
- Design methodologies for parallel and distributed algorithms
- Implementation of parallel and distributed algorithms
- Middleware and web services
- Peer-to-peer-networks
- Grid computing
- Speedup, efficiency, parallel complexity classes
- Limits of parallelism and lower bounds
- Motivation
- Software Architectures
- Basics: HTTP, XML & Co
- N-Tier Applications
- Service-Oriented and Event-Driven Architectures (SOA and EDA)
- Web-Oriented Architectures (Web 2.0)
- Overlay Networks
- Peer-to-Peer
- Grid und Cloud Computing
- Internet of Things

Qualification-goals/Competencies:

- Students can describe the design and function of parallel and distributed systems
- They can design and implement parallel and distributed algorithms
- They can analyze parallel and distributed systems and algorithms
- They can describe the limits or parallelism and distributed computations.
- The students are able to name the most important archiectures for distributed systems, explain them, and compare them to each other.
- For each architecture, they know the most prominent and important implementation platforms and basically know how to use them.
- For a given problem, they can analyze which architecture is best suited to solve it, and they can design a plan for the solution's realization.

Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr. rer. nat. Till Tantau

Teacher:

- Institute of Telematics
- Institute for Theoretical Computer Science

- Prof. Dr. rer. nat. Till Tantau
- Prof. Dr. Stefan Fischer

Literature:

- Jaja: An Introduction to Parallel Algorithms - Addison Wesley, 1992
- Quinn: Parallel Programming in C with MPI and OpenMP - McGraw Hill, 2004
- J. Dunkel, A. Eberhart, S. Fischer, C. Kleiner, A. Koschel: Systemarchitekturen für verteilte Anwendungen - Hanser-Verlag 2008
- I. Melzer et.al.: Service-Orientierte Architekturen mit Web Services - Spektrum-Verlag 2010

Language:

- offered only in German

CS4513-KP12, CS4513 - Web and Data Science (WebScience)

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

Course of study, specific field and term:

- Master CLS 2010 (optional subject), computer science, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (advanced module), technology field computer science, 2nd or 3rd semester
- Master Computer Science 2014 (advanced module), advanced curriculum, 2nd or 3rd semester

Classes and lectures:

- CS5130 T: Foundations of Ontologies and Databases for Information Systems (lecture with exercises, 3 SWS)
- CS5131 T: Web Mining Agents (lecture with exercises, 6 SWS)

Workload:

- 180 Hours private studies
- 135 Hours in-classroom work
- 45 Hours exam preparation

Contents of teaching:

- The term Web and Data Science refers to the study of the connection between data on the web and associated web services for the benefit of humans. Phenomena of technical, economic and social contexts of a system design perspective are examined so that web and data analysis drive new applications for people.
- Web and Data Science introduces the basics of the analysis and design of large networked information systems. The lack of a global control for distributed data (with different structure) and the lack of formal structure is an essential element we investigate in this module.
- The modules sets out how autonomous units can analyze data in a controlled cooperation scenario such that data can become information for humans and formally defined requirements are met.
- For more information see the module parts.

Qualification-goals/Competencies:

- Students will gain in-depth knowledge, solid skills and extensive expertise in the field of information systems, so that, for example, latest achievements of Web search engines can be exploited (see, e.g., Google Knowledge Vault), and students can successfully work in research projects as well as practical projects in industry.
- For more information see the module parts.

Grading through:

- Oral examination

Responsible for this module:

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

Teacher:

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

Language:

- offered only in English

Notes:

A combination with the advance IFIS module Data Management (CS4508) is useful for studying aspects of distributed and mobile data management, and for performing complementary practical work in the field of parallel processing of large data volumes. In contrast to the mobile-data assumption in Data Management, it is assumed in Web and Data Science that rather than data, interpretation processes are mobile in the form of agents. Agents have the task to autonomously determine and integrate a high-level data interpretation which is ultimately communicated to a user process.

Other complementary advanced modules such as Internet Technologies or Learning Systems offer interesting perspectives as well.

This module will be replaced by CS4514-KP12 Intelligent Agents.

EC4000-KP12, EC4000 - Business Administration Basics (Entre0)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	12

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (compulsory), entrepreneurship, 1st semester
- Master Entrepreneurship in Digital Technologies 2014 (compulsory), entrepreneurship, 1st semester

Classes and lectures:

- EC4001 T General Business Administration (lecture with exercises, 3 SWS)
- EC4004 T Strategic management (lecture with exercises, 3 SWS)
- Siehe EC4006 T: Entrepreneurship and Innovation (lecture with exercises, 3 SWS)

Workload:

- 180 Hours private studies
- 135 Hours in-classroom work
- 45 Hours exam preparation

Contents of teaching:

Qualification-goals/Competencies:

- Students develop a basic understanding of economics as a science and gain essential knowledge of key terms and concepts of business administration as well as their application. On this basis, they are in a position to analyze business decisions, structure and optimize, analyze business processes and design and implement the strategic management process.
- The students will be able to understand and assess the importance of e-business for companies in the context of overall economic and social developments, to understand the electronic value chain and how additional value can be created by the use of information and communication technologies (ICT) and how to use it conceptually.They are taught to know the basic technologies (hardware, software and networks) that are needed to build an e-business infrastructure, to understand their functioning and to assess their potential.In addition, they are capable of knowing and explaining trends in the Internet, especially the web 2.0, to understand and utilize the role of users in Web 2.0, to develop social media strategies in planned manner, to penetrate and understand the emergence of e-business projects and the associated change processes and challenges and also the role of IT, to understand and competently apply the analysis and selection process of e-business systems.
- Through this lecture, students will gain a basic understanding of the formation process and are also in a position to make a selection decision for a specific application based on different growth and internationalization strategies, to meter the time factor an appropriate importance in the context of market entry decisions, to make the right decision respective to the situation and to deal critically with with the topic Growth at any price. With regard to the topic of financing strategies, students will be able to point out the main sources and causes of financing, determine the financing effects of venture capital using an analytical instrument and make a well-founded selection decision independently on the basis of a holistic evaluation approach of financing alternatives.

Grading through:

- portfolio exam

Responsible for this module:

- Prof. Dr. Christian Scheiner

Teacher:

- Institute for Entrepreneurship and Business Development

- Prof. Dr. Christian Scheiner
- Dr. Stefan Becker
- Simon Behrendt

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- none

Prerequisites for participation in module exam(s):
- none
- Prerequisites for admission to the (written) examination may be scheduled at the beginning of the semester. When prerequisites are defined, they should be completed and positively evaluated before the initial (written) examination.

Module exam(s):
- EC4000-L1: Business Administration Basics, Portfolio exam consisting of EC4001-L1, EC4004-L1 and EC4008-L1, 100% of the module grade (module parts each 33.33%)

(The module consists of EC4001 T, EC4004 T and EC4008 T)

EC4500-KP08, EC4500 - Entrepreneurial thinking and acting (Entre1)

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

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (compulsory), entrepreneurship, 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (compulsory), entrepreneurship, 2nd semester

Classes and lectures:

- EC4500 A: Negotiation (lecture with exercises, 3 SWS)
- EC4500 B: Entrepreneurial Behavior (lecture with exercises, 3 SWS)

Workload:

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

Contents of teaching:

Qualification-goals/Competencies:

- The students know basic communication and negotiation techniques and can apply them successfully in typical conversational situations of executives and in a separate trial.They also learn to assess and control their own impact on others by appearance, language and behavior in conversations.
- After attending the course, students are able to analyze and evaluate psychological characteristics and processes of entrepreneurs and entrepreneurial teams, to apply entrepreneurial thinking and action principles to make theoretically informed business decisions, to assess motivation concepts, to guide and develop staff and to assess and evaluate the impact of the entrepreneurial spirit to the actions.

Grading through:

- portfolio exam

Responsible for this module:

- Prof. Dr. Christian Scheiner

Teacher:

- Institute for Entrepreneurship and Business Development
- Prof. Dr. Christian Scheiner

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- none

Prerequisites for participation in module exam(s):
- none
- Prerequisites for admission to the (written) examination may be scheduled at the beginning of the semester. When prerequisites are defined, they should be completed and positively evaluated before the initial (written) examination.

Module exam(s):
- EC4500-L1: Entrepreneurial Thinking and Acting, Portfolio exam consisting of EC4501-L1, 50 % of the module grade, and EC4502-L1, 50 % of the module grade

(The module consists of EC4500 A and EC4500 B)

EC4503-KP04 - Entrepreneurship and Olympic Strategies (EnuOS)

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

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (optional subject), entrepreneurship, 2nd semester
- Master Interdisciplinary Courses (optional subject), Interdisciplinary modules, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (optional subject), entrepreneurship, 2nd semester

Classes and lectures:

- EC4503-V: Entrepreneurship and Olympic Strategies (lecture, 2 SWS)
- EC4503-Ü: Entrepreneurship and Olympic Strategies - Development of a campaign (exercise, 2 SWS)

Workload:

- 60 Hours work on project
- 60 Hours in-classroom work

Contents of teaching:

- Creative solution finding
- Team building
- Management duties and responsibility
- Acting under uncertainty
- Strategy building
- Strategy
- Dealing with turbulent environmental conditions
- Identification and evaluation of opportunities and possibilities
- Dealing with stress
- Acting under restrictive conditions

Qualification-goals/Competencies:

- The students recognize the most important questions in the context of a start-up project and a young company and have afterwards basic scientific knowledge.
- Students are able to apply this knowledge to their own examples and in a changing context.
- Students can identify characteristics and factors of successful start-up projects and tasks, evaluate them on the basis of criteria and acquired methods, and develop and visualise them independently.
- The combination of sailing and sport provides a direct application reference.
- Students will be able to apply simple scientific basics from start-up research.
- Students can plan and carry out work steps in solving problems even in new and unfamiliar as well as interdisciplinary contexts.
- Students can define goals for their own development, reflect on their own strengths and weaknesses, plan their own development and reflect on their own foundations.
- Students can work cooperatively and responsibly in groups and critically reflect and expand their own cooperative behaviour in groups.

Grading through:

- written homework

Responsible for this module:

- Prof. Dr. Christian Scheiner

Teacher:

- Institute for Entrepreneurship and Business Development
- Prof. Dr. Kathrin Adlkofer

Literature:

- :
- :
- :

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- none

Prerequisites for participation in module exam(s):
- none

Module exam(s):
- EC4503-L1: Entrepreneurship and olympic strategies, written homework, 100 % of module grade

In the module Entrepreneurship and olympic strategies , students learn about the similarities between olympic strategies and entrepreneurship and which lessons of olympic strategies can be adopted in the context of start-up ventures.

This is a block course.

EC4510-KP06, EC4510 - Entrepreneurial and High-Tech-Marketing (EntMark)

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

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (compulsory), entrepreneurship, 2nd semester
- Master Interdisciplinary Courses (optional subject), Interdisciplinary modules, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (compulsory), entrepreneurship, 2nd semester

Classes and lectures:

- Entrepreneurial and High-Tech-Marketing (lecture, 2 SWS)
- Entrepreneurial and High-Tech-Marketing (exercise, 2 SWS)

Workload:

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

Contents of teaching:

- The first purpose of this lecture is to explain the essential differences between classical and entrepreneurial marketing.
- In addition, the characteristics of innovation marketing and in particular the marketing of high-tech and innovative products will be discussed. Building on this, special features and design possibilities in the field of entrepreneurial marketing will be further explained and deepened.

Qualification-goals/Competencies:

- Students have comprehensive and detailed knowledge on the latest state of knowledge in the field of entrepreneurial marketing.
- Students are able to develop and apply marketing strategies for innovative and creative (product) ideas.
- The competences and skills acquired in this subject can thus be applied in the future to tasks in new and unfamiliar situations using innovative marketing concepts and strategies.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr. Christian Scheiner

Teacher:

- Institute for Entrepreneurship and Business Development
- Prof. Dr. Marc Opresnik

Literature:

- J. Freiling, T. Kollmann: Entrepreneurial Marketing - Wiesbaden, 2008
- Hollensen / Opresnik: Grundlagen und Praxis. Ein managementorientierter Ansatz - Lübeck, 2020
- Kotler / Armstrong / Opresnik: Marketing: An Introduction - 14. Aufl., Harlow, 2019
- Kotler / Keller / Opresnik: Marketing-Management: Strategien für wertschaffendes Handeln - 15. Aufl., München, 2017
- J. Mohr, Sengupta, S., Slater, S.: Marketing of High-Technology Products and Innovations - 2013
- Opresnik: Die Macht der Kommunikativen Intelligenz nutzen. Einfach intelligent erklärte Strategien und Taktiken für erfolgreiche Verhandlungsführung - 1. Aufl., Lübeck, 2020

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- none

Prerequisites for participation in module exam(s):
- none

Module exam(s):
- EC4510-L1: Entrepreneurial- and High-Tech-Marketing, written exam, 120 min, 100 % of module grade

Students for whom this course is a compulsory module have priority.

Registration takes place at the beginning of the semester via Moodle. Further questions related to registration and exam will be clarified during the first lectures.

Please note the different lecture periods of the universities.

EC5000-KP08, EC5000 - Innovation Management (Entre2)

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

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (compulsory), entrepreneurship, 3rd semester
- Master Entrepreneurship in Digital Technologies 2014 (compulsory), entrepreneurship, 3rd semester

Classes and lectures:

- see EC4005 T: Innovation and Technology Management (lecture with exercises, 3 SWS)
- EC5000 B: Businessplan (lecture with project, 3 SWS)

Workload:

- 90 Hours in-classroom work
- 75 Hours work on project
- 60 Hours private studies
- 15 Hours exam preparation

Contents of teaching:

Qualification-goals/Competencies:

- The students will be in a position to describe terms and concepts in the field of innovation and entrepreneurship, to understand the context and to explain objectives and functions.
- In particular, students will be in a position to identify, evaluate and process-oriented implement start-up potential as future entrepreneurs and intrapreneurs on the basis of entrepreneurial thinking and action skills, to control and assess innovation activities even with limited resources and to assess the importance and relevance of external technology developments for understanding of their own company.
- The students are able to collect and evaluate business ideas for a potential business start-up and develop them in the form of a detailed business plan.

Grading through:

- portfolio exam

Responsible for this module:

- Prof. Dr. Christian Scheiner

Teacher:

- Institute for Entrepreneurship and Business Development

- Prof. Dr. Christian Scheiner
- Dr. Stefan Becker

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- none

Prerequisites for participation in module exam(s):
- none
- Prerequisites for admission to the (written) examination may be scheduled at the beginning of the semester. When prerequisites are defined, they should be completed and positively evaluated before the initial (written) examination.

Module exam(s):
- EC4500-L1: Innovation Management, Portfolio exam consisting of EC4507-L1, 50 % of the module grade, and EC5002-L1, 50 % of the module grade

(The module consists of EC4005 T and EC5000 T)

EC5010-KP04, EC5010 - Entrepreneurship in the digital economy (EEntre)

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

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (compulsory), entrepreneurship, 3rd semester
- Master Media Informatics 2014 (optional subject), Interdisciplinary modules, Arbitrary semester
- Master Interdisciplinary Courses (optional subject), Interdisciplinary modules, Arbitrary semester
- Master Robotics and Autonomous Systems 2019 (optional subject), interdisciplinary competence, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (compulsory), entrepreneurship, 3rd semester

Classes and lectures:

- Entrepreneurship in the digital economy (lecture, 2 SWS)
- Entrepreneurship in the digital economy (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- In this class students obtain a key insight into the entrepreneurial processes, the identification of business opportunities as well as the shaping and changing of young companies. In addition, students are able to understand business models on a basic level. At the same time, this class will include strategy development, fundamental aspects of corporate marketing, growth forms and strategies, entrepreneurship in the context of established enterprises and social entrepreneurship.
- Special emphasize will be on start-ups in the digital economy.

Qualification-goals/Competencies:

- Students are able to identify the central issues in the process of founding a new company and have a broad Knowledge including the scientific basis as well as the practical application of the importance of entrepreneurship in economic and in a business context. Students are able to apply this knowledge to their own examples and in a changing context.
- Students are able to develop features and factors of successful start-ups and independently develop, visualize and submit business concepts based oncriteria and methods acquired. This knowledge is also linked to practicaland current topics and representable applications.
- Individual aspects of the event will be studied on selected case studies.
- Students master the scientific foundations and have specialized and in-depth expertise in innovation and technology management.
- Students know how to structure and solve problems even in new, unfamiliarand multidisciplinary contexts of innovation and technology management.
- Students are able to define goals for their own development and canreflect their own strengths and weaknesses, plan their individualdevelopment and reflect the societal impact.
- Students can work cooperatively and responsibly in groups and reflect and enhance their own cooperative behavior in groups critical.

Grading through:

- portfolio exam

Responsible for this module:

- Prof. Dr. Christian Scheiner

Teacher:

- Institute for Entrepreneurship and Business Development
- Prof. Dr. Christian Scheiner

Literature:

- Bygrave & Zacharakis: The Portable MBA in Entrepreneurship - Wiley-Verlag: 2010
- Bygrave & Zacharakis: Entrepreneurship - Wiley-Verlag: 3. Auflage 2013
- Hisrich, Peters & Shepherd: Entrepreneurship - McGraw-Hill: International Edition 2010

Language:

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

Notes:

Prerequisites for attending the module:
- none

Prerequisites for participation in module exam(s):
- none
- Prerequisites for admission to the (written) examination may be scheduled at the beginning of the semester. When prerequisites are defined, they should be completed and positively evaluated before the initial (written) examination.

Module exam(s):
- EC5010-L1: Entrepreneurship in the Digital Economy, portfolio exam, 100 % of module grade

The portfolio exam consists of the following:
-Group work(s) (Presentation), 40 %
-(Online)exams, 60 %

The commercial rounding is used to determine the overall grade.

Students for whom this course is a compulsory module have priority.

Registration takes place at the beginning of the semester via Moodle. Further questions related to registration and exam will be clarified during the first lectures.

(Formerly EC5010-KP04)

EC5020-KP06, EC5020 - Business game (PlanSp)

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

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (compulsory), entrepreneurship, 3rd semester
- Master Interdisciplinary Courses (optional subject), Interdisciplinary modules, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (compulsory), entrepreneurship, 3rd semester

Classes and lectures:

- Business game (lecture, 1 SWS)
- Business game (project work, 3 SWS)

Workload:

- 120 Hours work on project
- 60 Hours in-classroom work

Contents of teaching:

- Students create a virtual enterprise as a team.
- In several periods the different establishment stages occur: founding, creatiion of a business plan, market entry and business development in competition with other teams.
- On the basis of the indicators, decisions for the next periods are taken.

Qualification-goals/Competencies:

- Students are able to analyze and understand the organizational context.
- Based on the available information and analysis they can make decisions and understand the impact of their decisions on performance measures.
- Students are able to develop and apply strategies and solve problems for their virtual company.
- The social skills and personal skills such as teamwork, entrepreneurship, communication skills are promoted among the students.

Grading through:

- successful addressing of the project goals

Responsible for this module:

- Prof. Dr. Christian Scheiner

Teacher:

- Institute for Entrepreneurship and Business Development
- Prof. Dr. Christian Scheiner

Literature:

- Manual will be provided: .

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- none

Prerequisites for participation in module exam(s):
- none
- Prerequisites for admission to the (written) examination may be scheduled at the beginning of the semester. When prerequisites are defined, they should be completed and positively evaluated before the initial (written) examination.

Module exam(s):
- EC5020-L1: Business Game, portfolio exam consisting of the successful solution of the project task, 100 % of module grade

Students for whom this course is a compulsory module have priority.

Registration takes place at the beginning of the semester via Moodle. Further questions related to registration and exam will be clarified during the first lectures.

(Formerly EC5020)

EC5500-KP30, EC5500 - Master Thesis Entrepreneurship in digital Technologies (MScEdT)

Duration:	Turnus of offer:	Credit points:
1 Semester	each semester	30

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (compulsory), entrepreneurship, 4th semester
- Master Entrepreneurship in Digital Technologies 2014 (compulsory), entrepreneurship, 4th semester

Classes and lectures:

- Master Thesis Entrepreneurship in digital Technologies (supervised self studies, 1 SWS)
- Colloquium (presentation (incl. preparation), 1 SWS)

Workload:

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

Contents of teaching:

- Necessary consolidation in field of work in a self organized work
- Scientific presentation about the problem and the solution developed

Qualification-goals/Competencies:

- The students can solve a complex scientific problem with the means of their profession.
- They elaborate a sophisticated scientific work within a given time.
- They have expert knowledge which they can apply to problems.
- They are able to analyze, interpret and critically assess scientific literature.
- They possess the communication skills to write down and present their scientific results in an appropriate way.

Grading through:

- Written report
- colloquium

Responsible for this module:

- Prof. Dr. Christian Scheiner

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

LS4130 A - Module part: Membrane Biophysics (Biophy2Mem)

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

Course of study, specific field and term:

- Master MES 2020 (module part), mathematics / natural sciences, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), mathematics / natural sciences, Arbitrary semester
- Master MES 2014 (module part), mathematics / natural sciences, Arbitrary semester
- Master MLS 2009 (Module part of a compulsory module), structure biology, 2nd semester

Classes and lectures:

- Basics of Membrane Biophysics (lecture, 2 SWS)
- Basics of Membrane Biophysics (exercise, 1 SWS)

Workload:

- 75 Hours private studies
- 45 Hours in-classroom work

Contents of teaching:

- Importance and function of cell membranes: structure, physical function and dynamic models
- Basics of the membrane components
- Thermodynamic self-assembling of lipids and reconstitution techniques
- Transmembrane and intrinsic membrane potentials
- Mechanical properties of lipid membranes
- Physical basics of membrane transport mechanisms
- Investigations using lipid monolayer
- Electrical and optical experiments using planar lipid bilayers
- Examples for interaction mechanisms between peptides/ proteins and planar membranes
- Spectroscopic methods on membranes and membrane proteins
- Light and force microscopy on membranes and membrane proteins
-

Qualification-goals/Competencies:

- The students can explain the components and the structure of biological membranes.
- They can explain the role and function of membrane lipids and proteins.
- They can explain the mechanical and electrical properties of membranes.
- They can explain the reconstitution of artificial lipid membranes.
- They can explain the methods for the investigation of artificial and natural membranes.
- They can explain the application of biophysical methods to biomedical questions, such as the characterization of membrane-active toxins.

Grading through:

- written exam

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Research Center Borstel, Leibniz Lung Center

- Prof. Dr. rer. nat. Thomas Gutsmann
- Prof. Dr. rer. nat. Andra Schromm
- Dr. Christian Nehls

Literature:

- Adam, P. Läuger, G. Stark: Physikalische Chemie und Biophysik - Springer-Verlag, 4. Auflage 2003
- W. Hanke, R. Hanke: Methoden der Membranphysiologie - Spektrum Akademischer Verlag, Auflage 1997
- Ole G. Mouritsen: Life - As a Matter of Fat - Springer 2005, ISBN 987-3-540-23248-3
- Thomas Heimburg: Thermal Biophysics of Membranes - Whiley-VCH 2007, ISBN 978-3-527-40471-1
- Lukas K. Buehler: Cell Membranes - Garland Science 2016, ISBN 978-0-8153-4196-3

Language:

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

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- None

Part of the module LS4130
One choise of two.

CS4138 T - Module part: Model Checking (ModelCha14)

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

Course of study, specific field and term:

- Master Computer Science 2019 (module part), Module part, Arbitrary semester
- Master MES 2020 (module part), computer science / electrical engineering, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master MES 2014 (module part), computer science / electrical engineering, 1st semester
- Master Computer Science 2014 (Module part of a compulsory module), Module part, Arbitrary semester

Classes and lectures:

- Model Checking (lecture, 3 SWS)
- Model Checking (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Quality aspects of software systems
- Analysis and verification techniques for software systems
- Basic techniques for model checking
- Advanced techniques for model checking

Qualification-goals/Competencies:

- The students can describe and compare analysis and verification techniques.
- They can construct, analyse and evaluate specifications of correctness and safety properties.
- They can characterize different system models and can formally represent sysstems in suitable models.
- They can illustrate different techniques for model checking hardware and software systems and can select and apply suitable techniques.
- They can explain the structure of model checkers and can use model checkers.
- They can evaluate the possibilities and limitations of model checking.

Grading through:

- exam type depends on main module

Responsible for this module:

- Siehe Hauptmodul

Teacher:

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

Literature:

- C. Baier, J.-P. Katoen: Principles of Model Checking - MIT Press, 2008

Language:

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

Notes:

(Is equal to CS4138SJ14)
(Part of Module CS4507)

Prerequisites for attending the module:
- None

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

CS4139 T - Module part: Runtime Verification and Testing (RVTestena)

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

Course of study, specific field and term:

- Master Computer Science 2019 (module part), Module part, Arbitrary semester
- Master MES 2020 (module part), computer science / electrical engineering, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master MES 2014 (module part), computer science / electrical engineering, 2nd semester
- Master Computer Science 2014 (Module part of a compulsory module), Module part, Arbitrary semester

Classes and lectures:

- Runtime Verification and Testing (lecture, 3 SWS)
- Runtime Verification and Testnig (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Quality aspects of software systems
- Analysis and verification techniques for software systems
- Testing levels
- Testing process
- Kinds of tests
- Test case generation
- Specification of correctness properties
- synthesis of monitors for the observation of software systems
- diagnosis of errors in software systems
- realization of monitoring frameworks

Qualification-goals/Competencies:

- The students can describe and compare analysis and verification techniques.
- They can construct, analyse and evaluate specifications of correctness and safety properties.
- They can illustrate different techniques for testing hardware and software systems and can select and apply suitable techniques.
- They can explain the operation process of test case generation tools and can clasify suitable applications.
- They can describe and apply techniques for the synthesis of monitors.
- With the acquired techniques they can develop software of higher quality.

Grading through:

- exam type depends on main module

Responsible for this module:

- Siehe Hauptmodul

Teacher:

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

Literature:

- G.J. Myers: The Art of Software Testing - John Wiley, 1979
- B. Beizer: Software Testing Techniques - Van Nostrand Reinhold, 1999
- M. Broy, B. Jonsson, J.-P. Katoen, M. Leucker, A. Pretschner: Model-Based Testing of Reactive Systems - Springer, 2005
- A. Bauer, M. Leucker, C. Schallhart: Runtime Verification for LTL and TLTL - ACM TOSEM, 2011
- C. Baier, J.-P. Katoen: Principles of Model Checking - MIT Press, 2008
- D. Peled: Software Reliability Methods - Springer, 2001

Language:

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

Notes:

(Is equal to CS4139)
(Part of Module CS4507)

Prerequisites for attending the module:
- None

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

CS4140 T - Module part: Mobile and Distributed Databases (MVDBa)

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

Course of study, specific field and term:

- Master Computer Science 2019 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master IT-Security 2019 (module part), Module part, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master Computer Science 2014 (module part), Module part, Arbitrary semester

Classes and lectures:

- Mobile und verteilte Datenbanken (lecture, 2 SWS)
- Mobile und verteilte Datenbanken (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- The contents of the lecture covers query processing, transactions and replication in
- - centralised database management systems
- - parallel database management systems
- - distributed database management systems
- - mobile database management systems

Qualification-goals/Competencies:

- Students can explain the differences between centralised, parallel, distributed and mobile database management systems.
- They can judge about the practical suitability of different synchronization approaches for distributed and mobile transactions for a given problem.
- They can apply approaches for distributed and mobile query processing.
- They can choose suitable replication approaches for a given application and justify their choices.
- They can recognize and deal with the special difficulties and sources of error in distributed and mobile environments.

Grading through:

- exam type depends on main module

Responsible for this module:

- Siehe Hauptmodul

Teacher:

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

Literature:

- A. Kemper, A. Eickler: Datenbanksysteme - 2006
- T. Conolly, C. Begg: Database Systems - A Practical Approach to Design, Implementation, and Management - Addison-Wesley 2005
- E. Rahm: Mehrrechner-Datenbanksysteme - Addison-Wesley 1994
- P. Dadam: Verteilte Datenbanken und Client/Server Systeme - Springer 1996
- H. Höpfner, C. Türker, B. König-Ries: Mobile Datenbanken und Informationssysteme - dpunkt.verlag 2005
- B. Mutschler, G. Specht: Mobile Datenbanksysteme - Springer 2004
- V. Kumar: Mobile Database Systems - Wiley-Interscience 2006

Language:

- offered only in German

Notes:

(Is equal to CS4140)
(Is module part of CS4508)

Entry requirements for taking the module:
- None

Admission requirements for taking module examination(s):
- see higher-level module

Module examination(s):
- see superordinate module

CS4151 T - Module part: Architectures for Distributed Applications (SVAa)

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

Course of study, specific field and term:

- Master Computer Science 2019 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master IT-Security 2019 (module part), Module part, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master Computer Science 2014 (module part), Module part, Arbitrary semester

Classes and lectures:

- Architectures for Distributed Applications (lecture, 2 SWS)
- Architectures for Distributed Applications (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Motivation
- Software Architectures
- Basics: HTTP, XML & Co
- N-Tier Applications
- Service-Oriented and Event-Driven Architectures (SOA and EDA)
- Web-Oriented Architectures (Web 2.0)
- Overlay Networks
- Peer-to-Peer
- Grid and Cloud Computing
- Internet of Things

Qualification-goals/Competencies:

- The students are able to name the most important archiectures for distributed systems, explain them, and compare them to each other.
- For each architecture, they know the most prominent and important implementation platforms and basically know how to use them.
- For a given problem, they can analyze which architecture is best suited to solve it, and they can design a plan for the solution's realization.

Grading through:

- exam type depends on main module

Responsible for this module:

- Prof. Dr.-Ing Horst Hellbrück

Teacher:

- Institute of Telematics
- Prof. Dr.-Ing Horst Hellbrück

Literature:

- J. Dunkel, A. Eberhart, S. Fischer, C. Kleiner, A. Koschel: Systemarchitekturen für verteilte Anwendungen - Hanser-Verlag 2008
- I. Melzer et.al.: Service-Orientierte Architekturen mit Web Services - Spektrum-Verlag 2010

Language:

- offered only in German

Notes:

IMPORTANT: No longer takes place as a module part of CS4509. Please now pay attention to the modules CS4151 and CS4517!

(Was module part of CS4509)
(Is equal to CS4151)
(Share of telematics in everything is 100%)

Entry requirements for taking the module:
- None

Admission requirements for taking module examination(s):
- see higher-level module

Module examination(s):
- see superordinate module

CS4220 T - Module part: Pattern Recognition (MEa)

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

Course of study, specific field and term:

- Master Computer Science 2019 (module part), Module part, Arbitrary semester
- Master MES 2020 (module part), computer science / electrical engineering, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master IT-Security 2019 (module part), Module part, 1st or 2nd semester
- Master Computer Science 2014 (module part), advanced curriculum, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master MES 2014 (module part), computer science / electrical engineering, 1st semester
- Master Computer Science 2014 (Module part of a compulsory module), specialization field robotics and automation, Arbitrary semester

Classes and lectures:

- Pattern Recognition (lecture, 2 SWS)
- Pattern Recognition (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Introduction to probability theory
- Principles of feature extraction and pattern recognition
- Bayes decision theory
- Discriminance functions
- Neyman-Pearson test
- Receiver Operating Characteristic
- Parametric and nonparametric density estimation
- kNN classifiers
- Linear classifiers
- Support vector machines and kernel trick
- Random Forest
- Neural Nets
- Feature reduction and feature transforms
- Validation of classifiers
- Selected application scenarios: acoustic scene classification for the selection of hearing-aid algorithms, acoustic event recognition, attention classification based on EEG data, speaker and emotion recognition

Qualification-goals/Competencies:

- Students are able to describe the main elements of feature extraction and pattern recognition.
- They are able to explain the basic elements of statistical modeling.
- They are able to use feature extraction, feature reduction and pattern classification techniques in practice.

Grading through:

- exam type depends on main module

Responsible for this module:

- Prof. Dr.-Ing. Alfred Mertins

Teacher:

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

Literature:

- R. O. Duda, P. E. Hart, D. G. Storck: Pattern Classification - New York: Wiley

Language:

- offered only in German

Notes:

Admission requirements for the module:
- None

Admission requirements for the examination:
- Successful completion of the exercises during the semester (at least 50% of the achievable points).

Module Exam:
- CS4220-L1: Pattern Recognition, written exam, 90 min, 100% of module grade.

(Is equal to CS4220SJ14)
(Is module part of CS4510, CS4290, CS5274-KP08)

CS4405 T - Module part: NeuroInformatics (NeuroInfa)

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

Course of study, specific field and term:

- Master Biophysics 2023 (module part), advanced curriculum, 2nd semester
- Master Computer Science 2019 (module part), Module part, Arbitrary semester
- Master MES 2020 (module part), computer science / electrical engineering, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master Medical Informatics 2019 (module part), Module part, Arbitrary semester
- Master Biophysics 2019 (module part), advanced curriculum, 2nd semester
- Master IT-Security 2019 (module part), Module part, 1st or 2nd semester
- Master Medical Informatics 2014 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master MES 2014 (module part), computer science / electrical engineering, 2nd semester
- Master Computer Science 2014 (module part), Module part, Arbitrary semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

- The human brain and abstract neuron models
- Learning with a single neuron:* Perceptrons* Max-Margin Classification* LDA and logistic Regression
- Network architectures:* Hopfield-Networks* Multilayer-Perceptrons* Deep Learning
- Unxupervised Learning:* k-means, Neural Gas and SOMs* PCA & ICA* Sparse Coding

Qualification-goals/Competencies:

- The students are able to understand the principle function of a single neuron and the brain as a whole.
- They know abstract neuronal models and they are able to name practical applications for the different variants.
- They are able to derive a learning rule from a given error function.
- They are able to apply (and implement) the proposed learning rules and approaches to solve unknown practical problems.

Grading through:

- exam type depends on main module

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute for Neuro- and Bioinformatics
- Prof. Dr. rer. nat. Thomas Martinetz

Literature:

- S. Haykin: Neural Networks - London: Prentice Hall, 1999
- J. Hertz, A. Krogh, R. Palmer: Introduction to the Theory of Neural Computation - Addison Wesley, 1991
- T. Kohonen: Self-Organizing Maps - Berlin: Springer, 1995
- H. Ritter, T. Martinetz, K. Schulten: Neuronale Netze: Eine Einführung in die Neuroinformatik selbstorganisierender Netzwerke - Bonn: Addison Wesley, 1991

Language:

- offered only in German

Notes:

Examination prerequisites can be defined at the beginning of the semester. If prerequisite courses are defined, they must have been completed and positively evaluated before the first examination.

(Is module part of CS4410, CS4511)
(Is equal to CS4405)

Admission requirements for the module:
- None

Admission requirements for the examination:
- Successful completion of exercises during the semester.

Translated with www.DeepL.com/Translator (free version)

CS4670 T - Module part: Ambient Computing (AmbCompa)

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

Course of study, specific field and term:

- Master Computer Science 2019 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master IT-Security 2019 (module part), Module part, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master Computer Science 2014 (module part), Module part, Arbitrary semester

Classes and lectures:

- Ambient Computing (lecture, 3 SWS)

Workload:

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

Contents of teaching:

- Current paradigms in computer technology
- Smart components
- Software architectures
- Context-sensitive systems
- Ambient Intelligence
- Interactive ambient media systems
- Ambient Computing Applications (AAL)
- Ethical, Legal and Social Implications (ELSI).

Qualification-goals/Competencies:

- The students are able to evaluate possibilities, concepts and challenges of Ambient Systems
- They have an overview about current technologies and systems for developing Ambient Systems
- They are able to follow and judge state-of-the-art research in the area of Ambient Computing

Grading through:

- exam type depends on main module

Responsible for this module:

- Siehe Hauptmodul

Teacher:

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

Literature:

- John Krumm: Ubiquitous Computing Fundamentals - CRC Press, 2009
- Stefan Poslad: Ubiquitous Computing: Smart Devices, Environments and Interactions - Wiley, 2009
- Uwe Hansman et al: Pervasive Computing - Springer, 2003

Language:

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

Notes:

(Is part of the module CS4503-KP12)

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- see higher-level module

Module examination(s):
- see superordinate module

CS5130 T - Module part: Foundations of Ontologies and Databases for Information Systems (OntoDBa)

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

Course of study, specific field and term:

- Master CLS 2010 (module part), computer science, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master Computer Science 2014 (module part), Module part, Arbitrary semester

Classes and lectures:

- Foundations of Ontologies and Databases in Information Systems (lecture, 2 SWS)
- Foundations of Ontologies and Databases in Information Systems (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Fundamentals of databases, conceptual modeling languages (ontologies), query languages, processes, and agents
- Ontology based data access (OBDA)
- Ontology evolution and ontology integration
- Data exchange and data integration (schema mappings, duplicate detection, inconsistency handling, integration with relational and ontological constraints as well as with incomplete data)
- Data stream processing (e.g., for sensor networks, robotics, web agents) with OBDA and complex event processing (CEP)
- Non-symbolic data and their symbolic annotations (e.g., for applications in bioinformatics/computational biology and for media interpretation), syntax, semantics, hybrid decision and computation problems and their complexity, (analysis of) algorithms
- Data- and ontology-oriented process analysis (e.g., for biological pathways) and process design (e.g., for non-trivial business processes)

Qualification-goals/Competencies:

- Knowledge: The module aims at introducing the students to the formal basics of databases and ontologies, so that they get an overview of concepts, methods, and theories for understanding, analyzing, and designing information systems in open large contexts, such as the web.
- Skills: The students get a basic understanding of logical and formal methods, which allows them to assess the possibilities and limitations of information systems, be it concrete ones or those that still have to be designed. Assessment parameters are correctness and completeness (Does the system produce what is expected? If so, does it produce all results?) as well as expressiveness (Is it possible to formulate all required queries? What are equivalent query languages?) and, last but not least, performance (How long does it take the system to come up with an answer? How much space does it need?). In addition to these analysis skills, students receive logical modeling skills using real application scenarios from industry (business processing, integration of data resources, processing of time-based and event data), and medicine (sensor networks, genomic ontologies, annotation). Based on these, the student not only acquires the ability to assess which logical model is suitable for which application scenario, but also the ability to construct their own logical models where necessary.
- Social Competence und Independent Work: Students work in groups to solve small exercises and project problems and sketch their solutions in short presentations. Independent work is promoted by exercises with practical ontology and database systems.

Grading through:

- exam type depends on main module

Is requisite for:

- Web-Mining Agents (CS5131-KP08, CS5131)

Responsible for this module:

- Siehe Hauptmodul

Teacher:

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

Literature:

- S. Abiteboul, R. Hull, V. Vianu: Foundations of Databases - Addison-Wesley, 1995
- M. Arenas, P. Barcelo, L. Libkin, and F. Murlak: Foundations of Data Exchange - Cambridge University Press, 2014
- F. Baader, D. Calvanese, D.L. McGuinness, D. Nardi, and P.F. Patel-Schneider (Eds.): The Description Logic Handbook: Theory, Implementation, and Applications - Cambridge University Press, 2010
- S. Chakravarthy, Q. Jiang: Stream Data Processing A Quality of Service Perspective - Springer, 2009
- L. Libkin: Elements Of Finite Model Theory (Texts in Theoretical Computer Science. An Eatcs Series) - SpringerVerlag, 2004

Language:

- offered only in English

Notes:

Prerequisites for this module are:
- Algorithm and Data Structures (CS1001)
- Linear Algebra and Discrete Structures I+II (MA1000, MA1500)
- Databases (CS2700)

Recommended additional modules:
- Logic (CS1002)
- Bachelor Project Computer Science (CS3701), topic: logic programming
- Nonstandard Database Systems (CS3202)

CS5131 T - Module part: Web-Mining Agents (WebMininga)

Duration:	Turnus of offer:	Credit points:
1 Semester	not available anymore	8

Course of study, specific field and term:

- Certificate in Artificial Intelligence (Module part of a compulsory module), Module part, 1st semester
- Master IT-Security 2019 (module part), Module part, 1st or 2nd semester
- Master Computer Science 2019 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master Computer Science 2014 (module part), Module part, Arbitrary semester

Classes and lectures:

- Web-Mining Agents (lecture, 4 SWS)
- Web-Mining Agents (exercise, 1 SWS)
- Web-Mining Agents (practical course, 1 SWS)

Workload:

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

Contents of teaching:

- Probabilities and generative models for discrete data
- Gaussian models, Bayesian and frequentist statistics, regression,
- Probabilistic graphical models (e.g., Bayesian networks), learning parameters and structures of probabilistic graphical models (BME, MAP, ML, EM algorithm), probabilistic classification, probabilistic relational models
- Probabilistic reasoning over time (dynamic Bayesian networks, Markov assumption, transition model, sensor model, inference problems: filtering, prediction, smoothing, most-likely explanation, hidden Markov models, Kalman filters, exact inferences and approximations, learning dynamic Bayesian networks)
- Structural Causal Networks (Intervention, instrumental Variables, counterfactuals)
- Mixture models, latent linear models (LDA, LSI, PCA), sparse linear models,
- Decision making under uncertainty (utility theory, decision networks, value of information, sequential decision problems, value iteration, policy iteration, MDPs, decision-theoretic agents, POMDPs, reduction to multidimensional continuous MDPs, dynamic decision networks)
- Game theory, decisions with multiple agents (Nash equilibrium, Bayes-Nash equilibrium), social choice (voting, preferences, paradoxes, Arrow's Theorem, mechanism design (controlled autonomy), rules of encounter
- Building and exchanging symbolic annotations for web data (from named entity recognition to discourse representations)
- Building and exchanging symbolic annotations for web data (from named entity recognition to discourse representations)
- Information association, retrieval, query answering and recommendation

Qualification-goals/Competencies:

- Knowledge:Students can explain the agent abstraction, define web mining of rational behavior, and give details about the design of mining agents (goals, utilities, environments). They can describe the main features of environments. The notion of adversarial agent cooperation can be discussed in terms of decision problems and algorithms for solving these problems. For dealing with uncertainty in real-world scenarios, students can summarize how Bayesian networks can be employed as a knowledge representation and reasoning formalism in static and dynamic settings. In addition, students can define decision making procedures in simple and sequential settings, with and with complete access to the state of the environment. In this context, students can describe techniques for solving (partially observable) Markov decision problems, and they can recall techniques for measuring the value of information. Students can identify techniques for simultaneous localization and mapping, and can explain planning techniques for achieving desired states. Students can explain coordination problems and decision making in a multi-agent setting in term of different types of equilibria, social choice functions, voting protocol, and mechanism design techniques.Students can explain the difference between instance-based and model-based learning approaches, and they can enumerate basic machine learning technique for each of the two basic approaches, either on the basis of static data, or on the basis of incrementally incoming data . For dealing with uncertainty, students can describe suitable representation formalisms, and they explain how axioms, features, parameters, or structures used in these formalisms can be learned automatically with different algorithms. Students are also able to sketch different clustering techniques. They depict how the performance of learned classifiers can be improved by ensemble learning, and they can summarize how this influences computational learning theory. Algorithms for reinforcement learning can also be explained by students.
- Skills:Students can select an appropriate agent architecture for concrete agent application scenarios. For simplified agent application students can derive decision trees and apply basic optimization techniques. For those applications they can also create Bayesian networks/dynamic Bayesian networks and apply Bayesian reasoning for simple queries. Students can also name and apply different sampling techniques for simplified agent scenarios. For simple and complex decision making students can compute the best action or policies for concrete settings. In multi-agent situations students will apply techniques for finding different equilibria states, e.g., Nash

equilibria. For multi-agent decision making students will apply different voting protocols and compare and explain the results.Students derive decision trees and, in turn, propositional rule sets from static data as well and temporal or streaming data. Students present and apply the basic idea of first-order inductive leaning. They apply the BME, MAP, ML, and EM algorithms for learning parameters of Bayesian networks and compare the different algorithms. They also know how to carry out Gaussian mixture learning. Students can describe basic clustering techniques and explain the basic components of those techniques. Students compare related machine learning techniques, e.g., k-means clustering and nearest neighbor classification. They can distinguish various ensemble learning techniques and compare the different goals of those techniques.

- Social competence: Students work in groups in order to solve small exercise and project assignments and present them in short talks in the plenum. In the associated project lab the students the develop a larger project using up-to-date programing languages and software tools for data science applications.

Grading through:

- exam type depends on main module

Responsible for this module:

- Siehe Hauptmodul

Teacher:

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

Literature:

- M. Hall, I. Witten and E. Frank: Data Mining: Practical Machine Learning Tools and Techniques - Morgan Kaufmann, 2011
- D. Koller, N. Friedman: Probabilistic Graphical Models: Principles and Techniques - MIT Press, 2009
- K. Murphy: Machine Learning: A Probabilistic Perspective - MIT Press, 2012
- S. Russel, P. Norvig: Artificial Intelligence: A Modern Approach - Pearson Education, 2010
- Y. Shoham, K. Leyton-Brown: Multiagent-Systems: Algorithmic, Game-Theoretic, and Logical Foundations - Cambridge University Press, 2009
- : References to journal articles on special themes are given in the lecture

Language:

- offered only in English

Notes:

Admission requirements for the module:
- None

Admission requirements for the examination:
- Examination prerequisites may be defined at the beginning of the semester. If prerequisites are defined, they must have been completed and positively evaluated prior to the initial examination.

The competencies of the following modules are required for this module (no hard admission requirement):
- Algorithms and Data Structures (CS1001).
- Linear Algebra and Discrete Structures I + II (MA1000, MA1500)
- Databases (CS2700)
- Stochastics 1 (MA2510) or Fundamentals of Statistics (PY1800)
- Introduction to Logic (CS1002)
- Artificial Intelligence 1 (CS3204)
- Information Systems (CS4130)

(Equals CS5131)
(Is module part of CS4513, CS4514-KP12)

CS5140 T - Module part: Semantic Web (SemWeba)

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

Course of study, specific field and term:

- Master Computer Science 2019 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master IT-Security 2019 (module part), Module part, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master Computer Science 2014 (module part), Module part, Arbitrary semester

Classes and lectures:

- Semantic Web (lecture, 2 SWS)
- Semantic Web (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Introduction with overview of the W3C Semantic Web family of languages
- Data management for Semantic Web data, in particular indexing approaches
- Query processing for Semantic Web queries (central, parallel, and distributed, in particular in the cloud)
- Processing strategies for Semantic Web rules and ontologies

Qualification-goals/Competencies:

- Students can judge about the possibilities and limits of the Semantic Web.
- They can evaluate the consequences of the Semantic Web approach for data modelling, adminstration and processing, and finally for applications.
- They can develop Semantic Web applications.
- They can explain and apply specialized approaches for Semantic Web databases.
- They can discuss about open research questions in the area of the Semantic Web.

Grading through:

- exam type depends on main module

Responsible for this module:

- Siehe Hauptmodul

Teacher:

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

Literature:

- P. Hitzler, M. Krötzsch, S. Rudolph: Foundations of Semantic Web Technologies - Chapman & Hall / CRC, 2009
- T. Segaran, J. Taylor, C. Evans: Programming the Semantic Web - O'Reilly, 2009
- F. Bry, J. Maluszynski: Semantic Techniques for the Web - Springer, 2009
- J. T. Pollock: Semantic Web for Dummies - Wiley, 2009
- J. Hebeler, M. Fisher, R. Blace, A. Perez-Lopez, M. Dean: Semantic Web Programming - Wiley, 2009
- G. Antoniou, F. van Harmelen: A Semantic Web Primer - MIT Press, 2008
- V. Kashyap, C. Bussler, M. Moran: The Semantic Web - Springer, 2008
- S. Groppe: Data Management and Query Processing in Semantic Web Databases - Springer, 2011

Language:

- offered only in German

Notes:

(Is equal to CS5140)
(Is module part of CS4508)

Entry requirements for taking the module:
- None

Admission requirements for taking module examination(s):
- see higher-level module

Module examination(s):
- see superordinate module

CS5150 T - Module part: Organic Computing (OrganicCoa)

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

Course of study, specific field and term:

- Master Computer Science 2019 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master IT-Security 2019 (module part), Module part, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master Computer Science 2014 (Module part of a compulsory module), Module part, Arbitrary semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

- Basic principles of Organic Computing
- Self-organization and emergence
- Architecture and design of Organic Computing systems
- Organic Computing for distributed systems
- Organic Computing in Neuro- and Bionformatics
- Organic Grid
- Autonomous Systems

Qualification-goals/Competencies:

- Students are able to utilize the principles of organic computing on exemplary designs.
- They are able to explain the principles of Organic Computing.
- They are able to analyze emergence behavior in Organic Computing systems.

Grading through:

- exam type depends on main module

Responsible for this module:

- Siehe Hauptmodul

Teacher:

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

Literature:

- C. Müller-Schloer, H. Schmeck, T. Ungerer: Organic Computing A Paradigm Shift for Complex Systems - Birkhäuser, 2011
- R. P. Würtz: Organic Computing - Springer, 2008
- C. Klüver, J. Kluever, J. Schmidt: Modellierung komplexer Prozesse durch naturanaloge Verfahren - Springer Vieweg 2012

Language:

- offered only in German

Notes:

(Part of Module CS4290, CS4504-KP12)

Admission requirements for taking the module:
- None

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

Module Exam(s):
- CS5150-L1: Organic Computing, oral exam, 100% of the module grade

CS5153 T - Module part: Wireless Sensor Networks (DlSensorNa)

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

Course of study, specific field and term:

- Master Computer Science 2019 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master IT-Security 2019 (module part), Module part, 1st or 2nd semester
- Master Computer Science 2014 (Module part of a compulsory module), specialization field robotics and automation, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master Computer Science 2014 (module part), advanced curriculum, Arbitrary semester

Classes and lectures:

- Wireless Sensor Networks (lecture, 2 SWS)
- Wireless Sensor Networks (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Basics of Sensor Networks
- Architecture of Sensor Nodes and Sensor Networks
- Identities and addressing
- Wireless communication
- Data management and topology control
- Localization
- Energy harvesting
- Applications

Qualification-goals/Competencies:

- The students are able to present the potential, benefits and limitations of sensor networks.
- They are able to cope with analysis, design, and evaluation of protocols in sensor networks.
- They are able to interpret and pursue current research activities for sensor networks.

Grading through:

- exam type depends on main module

Responsible for this module:

- Siehe Hauptmodul

Teacher:

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

Literature:

- H. Karl, A. Willig: Protocols and Architectures of Wireless Sensor Networks, - Wiley, 2005
- F. Zhao, L. Guibas: Wireless Sensor Networks - Morgan Kaufmann, 2004
- B.-C. Renner: Sustained Operation of Sensor Nodes with Energy Harvesters and Supercapacitors - Books on Demand 2013

Language:

- offered only in English

Notes:

(Part of Modules CS4504-KP12)
(Is equal to CS5153)

Admission requirements for taking the module:
- None

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

Module Exam(s):
- CS5153-L1: Wireless Sensor Networks, oral exam, 100% of the module grade

CS5158 T - Module part: Advanced Internet Technologies (AdInternea)

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

Course of study, specific field and term:

- Master Computer Science 2019 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master IT-Security 2019 (module part), Module part, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master Computer Science 2014 (module part), Module part, Arbitrary semester

Classes and lectures:

- Advanced Internet Technologies (lecture, 2 SWS)
- Advanced Internet Technologies (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- 1. Fundamentals: Internet architecture, Border Gateway Protocol (BGP), Multi-Protocol Label Switching (MPLS)
- 2. Software-Defined Networking (SDN): Rationale, OpenFlow, P4
- 3. Transport Layer: QUIC, HTTP3, MQTT, IoT
- 4. Specialized network architectures: named data networking (NDN), LoRaWAN, delay-tolerant networking (DTN)
- 5. Future topics: security, future of the Internet

Qualification-goals/Competencies:

- Students understand the fundamental design decisions that led to the development of Internet protocols.
- They are familiar with basic, generally applicable criteria for network design (end-to-end argument, fate sharing, etc.).
- They can explain and apply current routing methods such as BGP, MPLS, and SDN in detail.
- They can explain the differences between modern transport protocols such as QUIC, HTTP, and MQTT and their predecessors, describe the protocols, and use them in their application contexts.
- They are familiar with the basic principles of current specialized network technologies such as NDN, LoRaWAN, and DTN and know when and how to use them.
- They have a clear idea of the development paths the Internet may follow in the future.

Grading through:

- exam type depends on main module

Responsible for this module:

- Prof. Dr. Stefan Fischer

Teacher:

- Institute of Telematics
- Dr. rer. nat. Florian-Lennert Lau

Literature:

- Kurose, J. F., & Ross, K. W.: Computer Networking: A Top-Down Approach - 9. Aufl., Pearson., 2025
- Chataut, R., Sharma, H., & Akl, R.: A Comprehensive Review of IoT Applications and Future Prospects. Sensors - MDPI, 2023
- Akamai Technologies: HTTP/3 and QUIC: Past, Present, and Future - 2021
- Saxena, D.: Named Data Networking: A Survey. Computer Science Review - Elsevier, 2016
- Castillo, V., Gómez, Á., Salcedo, J., & López, L.: Delay and Disruption Tolerant Networking for Terrestrial and TCP/IP Applications: A Systematic Literature Review - Journal of Cybersecurity and Privacy, 4(3), 493 520. MDPI, 2024

Language:

- German and English skills required

Notes:

(Was module part of CS4509)
(Is equal to CS5158)

Entry requirements to take the module:
- None

Admission requirements for participation in module examination(s):
- See higher-level module

Module examination(s):
- see superordinate module

CS5170 T - Module part: Hardware/Software Co-Design (HWSWCoda)

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

Course of study, specific field and term:

- Master Computer Science 2019 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master IT-Security 2019 (module part), Module part, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master Computer Science 2014 (module part), Module part, Arbitrary semester

Classes and lectures:

- Hardware/Software Co-Design (lecture, 2 SWS)
- Hardware/Software Co-Design (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- System design flow
- Basic architectures for HW/SW systems
- System design and modelling
- System synthesis
- Algorithms for scheduling
- System partitioning
- Algorithms for system partitioning
- Design systems
- Performance analysis
- System design and specification with SystemC
- Application examples

Qualification-goals/Competencies:

- Students are able to determine a suitable hardware/software architecture for a given system description
- They are able to determine and describe the pros and cons of implementation alternatives
- They are able to apply methods for system partitioning
- They are able to translate non-formal system descriptions into formal models
- They are able to explain the different steps in system synthesis
- They are able to estimate the quality of system designs
- They are able to create system descriptions in SystemC

Grading through:

- exam type depends on main module

Responsible for this module:

- Siehe Hauptmodul

Teacher:

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

Literature:

- F. Kesel: Modellierung von digitalen Systemen mit SystemC - Oldenbourg Verlag 2012
- Teich, J., Haubelt, C.: Digital Hardware/Software-Systeme. Synthese und Optimierung - Berlin: Springer 2007

Language:

- offered only in German

Notes:

(Is module part of CS4290, CS4505)
(Is equal to CS5170)

Admission requirements for taking the module:
- None

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

Module Exam(s):
- CS5170-L1: Hardware/Software Co-Design, oral exam, 100% of the module grade

CS5194 T - Module part: Practical Project in Signal and Image Processing (PrSigBildv)

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

Course of study, specific field and term:

- Master Biophysics 2023 (module part), advanced curriculum, 1st or 2nd semester
- Master Computer Science 2019 (module part), Module part, Arbitrary semester
- Master MES 2020 (module part), computer science / electrical engineering, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master Biophysics 2019 (module part), advanced curriculum, 1st or 2nd semester
- Master IT-Security 2019 (module part), Module part, 1st or 2nd semester
- Master MES 2014 (module part), computer science / electrical engineering, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master Computer Science 2014 (module part), Module part, Arbitrary semester

Classes and lectures:

- iRoom (practical course, 3 SWS)

Workload:

- 60 Hours group work
- 40 Hours private studies
- 20 Hours written report

Contents of teaching:

- Planning and realization of typical signal processing applications in a team

Qualification-goals/Competencies:

- Students will have comprehensive knowledge of using signal and image processing algorithms in practice.
- They are able to realize signal processing systems in teamwork and in a self-directed manner.
- They have the communication competency to document and present project results.

Grading through:

- exam type depends on main module

Requires:

- Signal processing (CS3100-KP04)
- Image processing (CS3203)

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute for Signal Processing
- Prof. Dr.-Ing. Markus Kallinger
- MitarbeiterInnen des Instituts

Language:

- offered only in German

Notes:

(Part of Module CS4510)

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- The project must be completed in order to take the exam in the module CS4510

Modul Exam:
- CS4510-L1: Signal Analysis, oral exam consisting out of Pattern Recognition, Selected Topics of Signal Analysis and Enhancement and

this project, 100% of module grade

CS5260SJ14 T - Module part: Speech and Audio Signal Processing (SprachA14a)

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

Course of study, specific field and term:

- Master Computer Science 2019 (module part), Module part, Arbitrary semester
- Master Biophysics 2023 (module part), advanced curriculum, 1st and 2nd semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master Biophysics 2019 (module part), advanced curriculum, 1st or 2nd semester
- Master IT-Security 2019 (module part), Module part, Arbitrary semester
- Master Computer Science 2014 (Module part of a compulsory module), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master MES 2014 (module part), computer science / electrical engineering, 1st or 2nd semester

Classes and lectures:

- Speech and Audio Signal Processing (lecture, 2 SWS)
- Speech and Audio Signal Processing (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Speech production and human hearing
- Physical models of the auditory System
- Dynamic compression
- Spectral analysis: Spectrum and Cepstrum
- Spectral perception and masking
- Vocal tract models
- Linear prediction
- Coding in time and frequency domains
- Speech synthesis
- Noise reduction and echo compensation
- Source localization and spatial reproduction
- Basics of automatic speech recognition

Qualification-goals/Competencies:

- Students are able to describe the basics of human speech production and the corresponding mathematical models.
- They are able to describe the process of human auditory perception and the corresponding signal processing tools for mimicing auditory perception.
- They are able to present basic knowledge of statistical speech modeling and automatic speech recognition.
- They can describe and use signal processing methods for source separation and room-acoustic measurements.

Grading through:

- exam type depends on main module

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute for Signal Processing
- Prof. Dr.-Ing. Markus Kallinger

Literature:

- L. Rabiner, B.-H. Juang: Fundamentals of Speech Recognition - Upper Saddle River: Prentice Hall 1993
- J. O. Heller, J. L. Hansen, J. G. Proakis: Discrete-Time Processing of Speech Signals - IEEE Press

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

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

Module examination(s):
- see superordinate module

(Is modul part of CS4290, CS4510, RO4290-KP04)
(Is the same as CS5260SJ14)

CS5275 T - Module part: Selected Topics of Signal Analysis and Enhancement (AMSAVa)

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

Course of study, specific field and term:

- Master Robotics and Autonomous Systems 2019 (module part), Module part Current Issues Robotics and Automation, 1st and/or 2nd semester
- Master Biophysics 2023 (module part), advanced curriculum, 2nd semester
- Master Computer Science 2019 (module part), Module part, Arbitrary semester
- Master MES 2020 (module part), computer science / electrical engineering, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master Biophysics 2019 (module part), advanced curriculum, 2nd semester
- Master IT-Security 2019 (module part), Module part, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master MES 2014 (module part), computer science / electrical engineering, 1st or 2nd semester
- Master Computer Science 2014 (module part), Module part, Arbitrary semester

Classes and lectures:

- Selected Topics of Signal Analysis and Enhancement (lecture, 2 SWS)
- Selected Topics of Signal Analysis and Enhancement (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Introduction to statistical signal analysis
- Autocorrelation and spectral estimation
- Linear estimators
- Linear optimal filters
- Adaptive filters
- Multichannel signal processing, beamforming, and source separation
- Compressed sensing
- Basic concepts of multirate signal processing
- Nonlinear signal processing algorithms
- Application scenarios in auditory technology, enhancement, and restauration of one- and higher-dimensional signals, Sound-field measurement, noise reduction, deconvolution (listening-room compensation), inpainting

Qualification-goals/Competencies:

- Students are able to explain the basic elements of stochastic signal processing and optimum filtering.
- They are able to describe and apply linear estimation theory.
- Students are able to describe the concepts of adaptive signal processing.
- They are able to describe and apply the concepts of multichannel signal processing.
- They are able to describe the concept of compressed sensing.
- They are able to analyze and design multirate systems.
- Students are able to explain various applications of nonlinear and adaptive signal processing.
- They are able to create and implement linear optimum filters and nonlinear signal enhancement techniques on their own.

Grading through:

- exam type depends on main module

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute for Signal Processing
- Prof. Dr.-Ing. Markus Kallinger

Literature:

- A. Mertins: Signaltheorie: Grundlagen der Signalbeschreibung, Filterbänke, Wavelets, Zeit-Frequenz-Analyse, Parameter- und

Signalschätzung - Springer-Vieweg, 3. Auflage, 2013
- S. Haykin: Adaptive Filter Theory - Prentice Hall, 1995

Language:
- offered only in German

Notes:

(Part of modules CS4290, CS4510, CS5400, RO4290-KP04, CS5274-KP08)
(Is equal to CS5275)

For Details see main module.

Prerequisites for attending the module:
- None

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

Modul exam in Main module:
- CS5275-L1: Selected Topics of Signal Analysis and Enhancement, written or oral exam, 100% of modul grade

CS5430 T - module part: Seminar Machine Learning (SemMaschLa)

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

Course of study, specific field and term:

- Master Biophysics 2023 (module part), advanced curriculum, 2nd semester
- Master Computer Science 2019 (module part), Module part, Arbitrary semester
- Master MES 2020 (module part), computer science / electrical engineering, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master Biophysics 2019 (module part), advanced curriculum, 2nd semester
- Master IT-Security 2019 (module part), Module part, 1st or 2nd semester
- Master MES 2014 (module part), computer science / electrical engineering, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master Computer Science 2014 (module part), Module part, Arbitrary semester

Classes and lectures:

- Seminar Machine Learning (seminar, 2 SWS)

Workload:

- 70 Hours private studies
- 30 Hours in-classroom work
- 20 Hours work on an individual topic with written and oral presentation

Contents of teaching:

- Independent study of a specific field of machine learning

Qualification-goals/Competencies:

- Students can read and understand scientific articles in the field of machine learning.
- Students can present the contents of scientific articles in the field of machine learning in a talk.

Grading through:

- exam type depends on main module

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute for Neuro- and Bioinformatics
- Prof. Dr.-Ing. Erhardt Barth
- MitarbeiterInnen des Instituts

Language:

- German and English skills required

Notes:

Admission requirements for the module:
- None

Admission requirements for the examination:
- Examination prerequisites may be defined at the beginning of the semester. If prerequisites are defined, they must have been completed and positively evaluated prior to the initial examination.

(Is part of the module CS4511)

CS5450 T - Module part: Machine Learning (MaschLerna)

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

Course of study, specific field and term:

- Master Biophysics 2023 (module part), advanced curriculum, 1st semester
- Master Computer Science 2019 (module part), Module part, Arbitrary semester
- Master MES 2020 (module part), computer science / electrical engineering, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master Biophysics 2019 (module part), advanced curriculum, 1st semester
- Master IT-Security 2019 (module part), Module part, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master MES 2014 (module part), computer science / electrical engineering, 1st or 2nd semester
- Master Computer Science 2014 (module part), Module part, Arbitrary semester

Classes and lectures:

- Machine Learning (lecture, 2 SWS)
- Machine Learning (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Representation learning, including manifold learning
- Statistical learning theory
- VC dimension and support vector machines
- Boosting
- Deep learning
- Limits of induction and importance of data ponderation

Qualification-goals/Competencies:

- Students can understand and explain various machine-learning problems.
- They can explain and apply different machine learning methods and algorithms.
- They can chose and then evaluate an appropriate method for a particular learning problem.
- They can understand and explain the limits of automatic data analysis.

Grading through:

- exam type depends on main module

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute for Neuro- and Bioinformatics
- Prof. Dr.-Ing. Erhardt Barth
- Prof. Dr. rer. nat. Thomas Martinetz

Literature:

- Chris Bishop: Pattern Recognition and Machine Learning - Springer ISBN 0-387-31073-8
- Vladimir Vapnik: Statistical Learning Theory - Wiley-Interscience, ISBN 0471030031
- Tom Mitchell: Machine Learning - McGraw Hill. ISBN 0-07-042807-7

Language:

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

Notes:

Admission requirements for taking the module:
- None

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

Module Exam(s):
- CS5450-L1: Machine Learning, oral exam, 100% of module grade.

(Is part of the module CS4290, CS4511, CS5400, CS4251-KP08)

EC4001 T - Module part: General Business Administration, esp. Personnel Management (ABWL)

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

Course of study, specific field and term:

- Bachelor Nutritional Medicine 2024 (Module part of a compulsory module), interdisciplinary competence, 5th semester
- Master Entrepreneurship in Digital Technologies 2020 (Module part of a compulsory module), Module part, 1st semester
- Bachelor Nutritional Medicine 2018 (Module part of a compulsory module), interdisciplinary competence, 5th semester
- Bachelor Nutritional Medicine 2016 (Module part of a compulsory module), interdisciplinary competence, 5th semester
- Master Entrepreneurship in Digital Technologies 2014 (Module part of a compulsory module), Module part, 1st semester

Classes and lectures:

- General Business Administration (lecture, 2 SWS)
- General Business Administration (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Theories in business administration
- Organisational forms
- Legal forms
- Accounting basics
- Theories on leaderhip and motivation

Qualification-goals/Competencies:

- The students get an important and in-depth overview of the single parts of business administration.
- Within this lecture, the students are empowered to identify and classify the different theoretical areas of business administration.
- Furthermore, students will be able to evaluate the different approaches and apply them to specific situations.

Grading through:

- portfolio exam

Responsible for this module:

- Prof. Dr. Christian Scheiner

Teacher:

- Institute for Entrepreneurship and Business Development
- Dr. Stefan Becker

Literature:

- Hungenberg, Wulf: Grundlagen der Unternehmensführung - Gabler-Verlag, 4. Auflage, 2011
- Wöhe: Einführung in die Allgemeine Betriebswirtschaftslehre - Vahlen-Verlag, 24. Auflage, 2010

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- none

Prerequisites for participation in module exam(s):
- none
- Prerequisites for admission to the (written) examination may be scheduled at the beginning of the semester. When prerequisites are defined, they should be completed and positively evaluated before the initial (written) examination.

Module exam(s):
- EC4001-L1: General Business Administration, (online) tests, 100 % of module grade

(Part of Module EC4000-KP12)
(Part of Module EW3560-KP11)
(Is equal to EC4001-KP04)
(Formerly EC4001 General Business Administration)

EC4004 T - Module part: Strategic Management (StratMng)

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

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (Module part of a compulsory module), Module part, 1st semester
- Master Entrepreneurship in Digital Technologies 2014 (Module part of a compulsory module), Module part, 1st semester

Classes and lectures:

- Strategic Management (lecture, 2 SWS)
- Strategic Management (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Corporate goals and strategies
- Marketing Strategies
- Enterprise Controlling
- Internationalization strategies

Qualification-goals/Competencies:

- Within the single teaching areas the students will be able to use the teaching content and to analyze and evaluate business cases independently.
- They are empowered to use and apply the different strategic management tools and approaches.
- Moreover, the team work within the lecture and exercise enables the students to formulate and define common goals and solution strategies with regard to the tasks given.

Grading through:

- portfolio exam

Responsible for this module:

- Prof. Dr. Christian Scheiner

Teacher:

- Institute for Entrepreneurship and Business Development
- Simon Behrendt

Literature:

- Hungenberg, Wulf: Grundlagen der Unternehmensführung - Gabler-Verlag, 4. Auflage, 2011
- Hungenberg: Strategisches Management in Unternehmen - Gabler-Verlag, 8. Auflage 2014
- Schierenbeck: Grundzüge der Betriebswirtschaftslehre - Oldenbourg-Verlag, 17. Auflage, 2008
- Schäfer-Kunz Vahs: Einführung in die Betriebswirtschaftslehre - Schäffer-Poeschel-Verlag, 5. Auflage, 2007
- Wöhe: Einführung in die Allgemeine Betriebswirtschaftslehre - Vahlen-Verlag, 24. Auflage, 2010

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- none

Prerequisites for participation in module exam(s):
- none
- Prerequisites for admission to the (written) examination may be scheduled at the beginning of the semester. When prerequisites are defined, they should be completed and positively evaluated before the initial (written) examination.

Module exam(s):
- EC4004-L1: Strategic Management, portfolio exam, 100 % of module grade

The portfolio exam consists of the following:
-Written assignment, 40 %
-Exam, 60 %

The commercial rounding is used to determine the overall grade.

(Part of Module EC4000-KP12)
(Is equal to EC4004-KP04)

EC4005 T - Module part: Innovation and Technology Management (IuTMng)

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

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (Module part of a compulsory module), Module part, 3rd semester
- Bachelor Nutritional Medicine 2016 (Module part of a compulsory module), interdisciplinary competence, 5th semester
- Master Entrepreneurship in Digital Technologies 2014 (Module part of a compulsory module), Module part, 3rd semester

Classes and lectures:

- Innovation and Technology Management (lecture, 2 SWS)
- Innovation and Technology Management (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Technology and innovation are the basis for success and growth of any business. This course deals with theories, concepts and tools for the management of technology and innovation. During the event, basic concepts of innovation and technology management are defined. In addition, corporate internal and external sources of innovation are discussed, before the search for business opportunities is covered. Furthermore, the course deals with the development of an innovation strategy, the establishment of innovation networks, the development of new products and services and business model innovations.
- The content is also linked to practical and current topics thus covering relevant applications.
- Individual aspects of the event will be studied on selected case studies.

Qualification-goals/Competencies:

- Students are able to master and apply scientific foundations and develop specialized and in-depth expertise in innovation and technology management.
- Students are able to structure and solve problems in innovation and technology management even in a new, unfamiliar and multidisciplinary context.
- Students are able to define goals for their own development and reflect their own strengths and weaknesses, plan their own development and reflect the societal impact.
- Students can work cooperatively and responsibly in groups and reflect and enhance their own cooperative behavior in groups critical.

Grading through:

- Written or oral exam as announced by the examiner

Responsible for this module:

- Prof. Dr. Christian Scheiner

Teacher:

- Institute for Entrepreneurship and Business Development
- Dr. Stefan Becker

Literature:

- Nichols: Social Entrepreneurship - Oxford University Press: 1. Auflage 2008
- Bessant & Tidd: Innovation and Entrepreneurship - Wiley-Verlag: 2. Auflage 2013
- Fisch & Roß: Fallstudien zum Innovationsmanagement - Gabler-Verlag: 1. Auflage 2009
- Bessant & Tidd: Managing Innovation: Integrating Technological, Market and Organizational Change - Wiley-Verlag: 5. Auflage 2013

Language:

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

Notes:

Prerequisites for attending the module:
- none

Prerequisites for participation in module exam(s):
- none
- Prerequisites for admission to the (written) examination may be scheduled at the beginning of the semester. When prerequisites are defined, they should be completed and positively evaluated before the initial (written) examination.

Module exam(s):
- EC4005-L1: Innovation and Technology Management, written exam, 60 min, 100 % of module grade, or as announced by examiner
- EC4005-L1: Innovation and Technology Management, oral exam, 15 min, 100 % of module grade

(Part of Module EC5000-KP08)
(Is equal to EC4007-KP04)
(Former EC4005)

EC4008 T - Module part: Entrepreneurship & Innovation (EuI)

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

Course of study, specific field and term:

- Bachelor Nutritional Medicine 2024 (Module part of a compulsory module), interdisciplinary competence, 5th semester
- Master Entrepreneurship in Digital Technologies 2020 (Module part of a compulsory module), Module part, 1st semester
- Bachelor Nutritional Medicine 2018 (Module part of a compulsory module), interdisciplinary competence, 5th semester
- Master Entrepreneurship in Digital Technologies 2014 (Module part of a compulsory module), Module part, 1st semester

Classes and lectures:

- Entrepreneurship and Innovation (lecture, 2 SWS)
- Entrepreneurship and Innovation (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- This course deals with fundamental theories, concepts and tools for the entrepreneurship and innovation management.
- The content is also linked to practical and current topics thus covering relevant applications.
- Individual aspects of the event will be studied on selected case studies.

Qualification-goals/Competencies:

- Students are able to master and apply scientific foundations and develop predominantly fundamental expertise in entrepreneurship and innovation.
- Students are able to structure and solve problems in innovation and technology management predominantly in a familiar be to some extent also even in a new, unfamiliar and multidisciplinary context.
- Students are able to define goals for their own development and reflect their own strengths and weaknesses, plan their own development and reflect the societal impact.
- Students can work cooperatively and responsibly in groups and reflect and enhance their own cooperative behavior in groups critical.

Grading through:

- portfolio exam

Responsible for this module:

- Prof. Dr. Christian Scheiner

Teacher:

- Institute for Entrepreneurship and Business Development
- Prof. Dr. Christian Scheiner

Literature:

- Nichols: Social Entrepreneurship - Oxford University Press 1. Auflage 2008
- Bessant & Tidd: Innovation and Entrepreneurship - Wiley-Verlag 2. Auflage 2013
- Fisch & Roß: Fallstudien zum Innovationsmanagement - Gabler-Verlag 1. Auflage 2009
- Bessant & Tidd: Managing Innovation: Integrating Technological, Market and Organizational Change - Wiley-Verlag: 5. Auflage 2013

Language:

- German and English skills required

Notes:

Prerequisites for attending the module:
- none

Prerequisites for participation in module exam(s):
- none
- Prerequisites for admission to the (written) examination may be scheduled at the beginning of the semester. When prerequisites are defined, they should be completed and positively evaluated before the initial (written) examination.

Module exam(s):
- EC4008-L1: Entrepreneurship and Innovation, portfolio exam, 100% of module grade

The portfolio exam consists of the following:
-Individual written assignment, 15 %
-Group work (Presentation), 45 %
-(Online)exams, 40 %

The commercial rounding is used to determine the overall grade.

(Part of Module EC4000-KP12)
(Part of Module EW3560-KP11)
(Is equal to EC4008-KP04)
(Replaces PS5830-KP04)

EC4500 A - Module part: Negotiation (Verfuehr)

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

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (Module part of a compulsory module), Module part, 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (Module part of a compulsory module), Module part, 2nd semester

Classes and lectures:

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

Workload:

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

Contents of teaching:

- Negotiation fundamentals
- Negotiation (sub-)processes
- Negotiation contexts
- Individual differences in negotiation
- Resolving differences
- Emotions in negotiations

Qualification-goals/Competencies:

- Students are able to identify the central issues in the process of negotiations and have a broad knowledge including the scientific basis as well as the practical application of the importance of negotiations in economic and in a business context.
- Students are able to apply this knowledge to their own examples.
- Individual aspects of negotiations will be studied on selected case studies and exercises
- Students master the scientific foundations and have specialized and in-depth expertise in negotiation.
- Students know how to prepare, structure and conduct negotiations.
- Students are able to define goals for their own development and can reflect their own strengths and weaknesses, plan their individual development and reflect the societal impact.
- Students can work cooperatively and responsibly in groups as well as reflect and enhance their own cooperative behavior in groups critical.

Grading through:

- portfolio exam

Responsible for this module:

- Prof. Dr. Christian Scheiner

Teacher:

- Institute for Entrepreneurship and Business Development
- Prof. Dr. Christian Scheiner

Literature:

- Hollensen, Oprensik: Marketing - A relationship approach - Vahlen Verlag, München, 2010
- Kotter: Wie Manager richtig führen - München / Wien, 1999
- Küpper, Ortmann: Mikropolitik. Rationalität, Macht und Spiele in Organisationen - Opladen, 2. Auflage, 1992
- Lürssen, Opresnik: Die heimlichen Spielregeln der Karriere. Wie Sie die ungeschriebenen Gesetze am Arbeitsplatz für ihren Erfolg nutzen - 3. Auflage, Frankfurt / New York, 2010
- Neuberger: Mikropolitik. Der alltägliche Aufbau und Einsatz von Macht in Organisationen - 2. Auflage, Stuttgart, 2006
- Opresnik: Die Geheimnisse erfolgreicher Verhandlungsführung - Besser verhandeln - in jeder Beziehung - Springer, 2013
- Opresnik, Rennhak: Allgemeine Betriebs- und Managementlehre, Grundlagen und Praxis einer integrierten marktorientierten Unternehmensführung - Gabler, 2011
- Seifert: Visualisieren - Präsentieren - Moderieren - 23. Auflage, Offenbach, 2009

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- none

Prerequisites for participation in module exam(s):
- none
- Prerequisites for admission to the (written) examination may be scheduled at the beginning of the semester. When prerequisites are defined, they should be completed and positively evaluated before the initial (written) examination.

Module exam(s):
- EC4501-L1: Negotiation, portfolio exam, 100 % of module grade

The portfolio exam consists of the following:
-Group work, 40 %
-(Online) tests, 60 %

The commercial rounding is used to determine the overall grade.

(Part of Module EC4500-KP08)
(Is equal to EC4501-KP04)
(Formerly EC4501 T)

EC4500 B - Module part: Entrepreneurial Behavior (EntrBehav)

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

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (Module part of a compulsory module), Module part, 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (Module part of a compulsory module), Module part, 2nd semester

Classes and lectures:

- Entrepreneurial Behavior (lecture, 2 SWS)
- Entrepreneurial Behavior (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Psychology of entrepreneurs and entrepreneurial teams
- Entrepreneurial decision making and implementation
- Motivation of employees
- Personnel management and personality development
- Influence of entrepreneurial passion on the actions of entrepreneurs
- Fundamentals in entrepreneurial and organizational behavior
- Stakeholder, top management, and principal-agent-theory
- Challenges in the organizational design
- Organizational culture
- Organizational learning
- Individual differences and diversity

Qualification-goals/Competencies:

- Students are able to identify the central issues in the context of entrepreneurial/organizational behavior and have a broad knowledge including the scientific basis as well as the practical application its importance.
- Students are able to apply this knowledge to their own examples and in a changing context.
- Individual aspects of the event will be studied on selected case studies.
- Students master the scientific foundations and have specialized and in-depth expertise in entrepreneurial and organizational behavior.
- Students know how to structure and solve problems even in new, unfamiliar and multidisciplinary contexts of entrepreneurial and organizational behavior.
- Students can work cooperatively and responsibly in groups and reflect and enhance their own cooperative behavior in groups critical.

Grading through:

- portfolio exam

Responsible for this module:

- Prof. Dr. Christian Scheiner

Teacher:

- Institute for Entrepreneurship and Business Development
- Prof. Dr. Christian Scheiner

Literature:

- Ansfried B. Weinert: Organisations- und Personalpsychologie - Beitz Verlag, Basel, 2004
- Lutz von Rosenstiel, Friedemann W. Nerdinger: Grundlagen der Organisationspsychologie - Schaeffer Poeschel Verlag, 7. überarbeitete Auflage
- Lioba Werth: Psychologie für die Wirtschaft - Spektrum Akademischer Verlag, 2004
- Dieter Frey, Hans Werner Bierhoff: Sozialpsychologie - Interaktion und Gruppe - Hogrefe Verlag, Göttingen 2011
- Peter Dowling, Marion Festing, Allen D. Engle: International Human Resource Management - 5th Edition, London, 2008

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- none

Prerequisites for participation in module exam(s):
- none
- Prerequisites for admission to the (written) examination may be scheduled at the beginning of the semester. When prerequisites are defined, they should be completed and positively evaluated before the initial (written) examination.

Module exam(s):
- EC4502-L1: Entrepreneurial Behavior, portfolio exam, 100 % of module grade

The portfolio exam consists of the following:
-Group work, 40 %
-(Online) tests, 60 %

The commercial rounding is used to determine the overall grade.

(Part of Module EC4500-KP08)
(Is equal to EC4502-KP04)
(Formerly EC4502 T)

EC5000 B - Module part: Business Plan (BusiPlan)

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

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (Module part of a compulsory module), Module part, 3rd semester
- Master Entrepreneurship in Digital Technologies 2014 (Module part of a compulsory module), Module part, 3rd semester

Classes and lectures:

- Business Plan (lecture, 1 SWS)
- Business Plan (exercise, 1 SWS)
- Business Plan (project work, 1 SWS)

Workload:

- 75 Hours work on project
- 45 Hours in-classroom work

Contents of teaching:

- During the business plan seminar, the business ideas for a potential business start-up are collected, evaluated and worked out in the form of a detailed business plan. The relevance of the business plan for business practice is to be demonstrated by means of specialist lectures on the individual components of the business plan.
- Students develop over the course period a business plan for a fictional or real business opportunity in teams.
- Business plan fundamentals
- Product and service description
- Market and competitor analysis
- Development of a marketing strategy
- Development of a distribution strategy
- Organizational structure
- Financing and financial planning

Qualification-goals/Competencies:

- Students are able to identify the central issues in the process of writing a business plan and have a broad knowledge including the scientific basis as well as its practical application.Business plan is an advanced course in the curriculum and requires the completion of fundamentals courses (e.g. Entrepreneurial, Marketing, Strategic Management, Fundamentals in Business Administration, etc.).
- Students are able to apply this knowledge to their own examples.Students master the scientific foundations and have specialized and in-depth expertise in writing a business plan.
- Students know how to prepare, structure and conduct negotiations.Students are able to define goals for their own development and can reflect their own strengths and weaknesses, plan their individual development and reflect the societal impact.
- Students can work cooperatively and responsibly in groups and reflect and enhance their own cooperative behavior in groups critical.

Grading through:

- portfolio exam

Responsible for this module:

- Prof. Dr. Christian Scheiner

Teacher:

- Institute for Entrepreneurship and Business Development

- Prof. Dr. Christian Scheiner
- Prof. Dr. Kathrin Adlkofer

Literature:

- Netzwerk Nordbayern: Handbuch zur Businessplan-Erstellung - 8. überarbeitete Auflage
- H. Klandt: Gründungsmanagement: Der integrierte Unternehmensplan - Verlag Oldenbourg, 2. Auflage, 2006
- M. E. Porter: On Competition. Updated and Expanded Edition - Harvard business review book series, 2008
- K. Kerth, H. Asum, V. Stich: Die besten Strategietools in der Praxis: Welche Werkzeuge brauche ich wann? Wie wende ich sie an? Wo liegen die Grenzen? - Carl Hanser Verlag, 5. Auflage, München, Wien, 2011

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- none

Prerequisites for participation in module exam(s):
- none
- Prerequisites for admission to the (written) examination may be scheduled at the beginning of the semester. When prerequisites are defined, they should be completed and positively evaluated before the initial (written) examination.

Module exam(s):
- EC5002-L1: Business Plan, portfolio exam, 100 % of module grade

The portfolio exam consists of the following:
-Written assignment, 60 %
-Presentation, 40 %

The commercial rounding is used to determine the overall grade.

(Part of Module EC5000-KP08)
(Is equal to EC5002-KP04)
(Former EC5002 T)

LS4020 C-MIW - Module part: Single molecule methods (EinzelStrT)

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

Course of study, specific field and term:

- Master MES 2020 (module part), mathematics / natural sciences, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master MES 2014 (module part), mathematics / natural sciences, Arbitrary semester

Classes and lectures:

- Single molecule methods (lecture, 2 SWS)
- Seminar Single molecule methods (seminar, 1 SWS)

Workload:

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

Contents of teaching:

- Physical Fundamentals of Fluorescence
- Photophysics
- Methods of single molecule fluorescence microscopy
- Protein labeling and immobilization
- Fluorescence Resonance Energy Transfer (FRET)
- Enzyme activity with single molecules
- Single molecule protein folding
- Physical basis of optical tweezers
- Protein folding with optical tweezers

Qualification-goals/Competencies:

- Students will be able to explain and apply the physical principles of fluorescence.
- They can explain and apply the basics of photophysics and photochemistry.
- They can select suitable detection methods for single molecules.
- They can select appropriate protein labelling methods.
- They can analyze and critically evaluate the data obtained.
- They have an overview of current research in the field of fluorescence spectroscopy of individual biomolecules.
- They have an insight into the structures of the research landscape.

Grading through:

- Written or oral exam as announced by the examiner

Requires:

- Introduction into Biophysics (LS2200-KP04, LS2200)

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute of Physics
- Prof. Dr. rer. nat. Christian Hübner

Literature:

- Lakowicz, Joseph R.: Principles of Fluorescence Spectroscopy - ISBN 978-0-387-46312-4
- Markus Sauer, Johan Hofkens, Jörg Enderlein: Handbook of Fluorescence Spectroscopy and Imaging: From Ensemble to Single Molecules - ISBN: 978-3-527-31669-4

Language:

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

Notes:

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

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

LS4020 F-MIW - Module part: Protein biophysics (PBPT)

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

Course of study, specific field and term:

- Master MES 2020 (module part), mathematics / natural sciences, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master MES 2014 (module part), mathematics / natural sciences, Arbitrary semester

Classes and lectures:

- Protein biophysics (lecture, 2 SWS)
- Protein biophysics (seminar, 1 SWS)

Workload:

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

Contents of teaching:

- Protein structure
- Energy landscapes
- Thermodynamics of protein folding
- Kinetics of protein folding
- Thermodynamics of enzymatic reactions
- Kinetics of enzymatic reactions

Qualification-goals/Competencies:

- Students will be able to name and explain the physical principles of protein folding, protein dynamics and protein interaction.
- Students can correctly apply the terms global state, micro state, sum of states, global variables and energy landscape.
- Students will be able to use the terms entropy and enthalpy correctly in the context of protein folding and protein interaction.
- Students can name and explain the basic principles of protein folding kinetics.

Grading through:

- Written or oral exam as announced by the examiner

Requires:

- Introduction into Biophysics (LS2200-KP04, LS2200)

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute of Physics
- Prof. Dr. rer. nat. Christian Hübner

Literature:

- Hans Frauenfelder, Shirley Chan und Winnie Chan: Physics of Proteins: An Introduction to Molecular Biophysics (Biological and Medical Physics, Biomedical Engineering) - Springer, Berlin (Gebundene Ausgabe - 30. Dezember 2010)
- Alan Fersht: Structure & Mechanism in Protein Science: Guide to Enzyme Catalysis and Protein Folding - W H Freeman & Co (Gebundene Ausgabe - 15. Februar 1999)

Language:

- offered only in German

Notes:

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

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

Identical to LS4020 F plus seminar

ME4030 T-INF - Module part: Inverse Problems in Imaging (InverPaInf)

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

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master Medical Informatics 2014 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master Computer Science 2014 (module part), Module part, Arbitrary semester

Classes and lectures:

- Inverse Problems in Imaging (lecture, 2 SWS)

Workload:

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

Contents of teaching:

- Introduction to inverse and ill-posed problems on the basis of selected examples (including seismology, impedance tomography, heat conduction, computed tomography, acoustic)
- Concept of ill-posedness of the inverse problem (Hadamard)
- Singular value decomposition and generalized inverse
- Regularization methods (eg Tikhonov, Phillips, Ivanov)
- Deconvolution
- Image restoration (deblurring, defocusing)
- Statistical methods (Bayes, maximum likelihood)
- Computed Tomography, Magnetic Particle Imaging

Qualification-goals/Competencies:

- Students are able to explain the concept of ill-posedness of the inverse problem and distinguish given inverse problems regarding good or bad posedness.
- They are able to formulate inverse problems of mathematical imaging and solve (approximate) with suitable numerical methods.
- They can assess the condition of a problem and the stability of a method.
- They master different regularization methods and are able to apply them to practical problems.
- They know methods to determine a suitable regularization.
- They can use methods of image reconstruction and restoration on real measurement data.

Grading through:

- exam type depends on main module

Responsible for this module:

- Prof. Dr. rer. nat. Thorsten Buzug

Teacher:

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

Literature:

- Kak and Slaney: Principles of Computerized Tomographic Imaging - SIAM Series 33, New York, 2001
- Natterer and Wübbeling: Mathematical Methods in Image Reconstruction - SIAM Monographs, New York 2001
- Bertero and Boccacci: Inverse Problems in Imaging - IoP Press, London, 2002
- Andreas Rieder: Keine Probleme mit inversen Problemen - Vieweg, Wiesbaden, 2003
- Buzug: Computed Tomography - Springer, Berlin, 2008

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

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

ME4250 A - Module part: Instrumentation in Biophysics (InBp)

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

Course of study, specific field and term:

- Master MES 2020 (module part), mathematics / natural sciences, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master MES 2014 (module part), mathematics / natural sciences, Arbitrary semester

Classes and lectures:

- Instrumentation in Biophysics (lecture, 2 SWS)
- Instrumentation in Biophysics (exercise, 1 SWS)

Workload:

- 75 Hours private studies
- 45 Hours in-classroom work

Contents of teaching:

- UV-VIS spectroscopy
- Atomic force microscopy
- Fluorescence spectroscopy
- Film balance
- Patch clamp

Qualification-goals/Competencies:

- Students will be able to identify the appropriate instrumentation for a particular biophysics question
- The students are able to further develop the instruments of biophysics.
- The students are able to optimally use the instruments of biophysics.

Grading through:

- Written or oral exam as announced by the examiner

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Research Center Borstel, Leibniz Lung Center
- Prof. Dr. rer. nat. Thomas Gutsmann
- Dr. Christian Nehls

Literature:

- Lukas K. Buehler: Cell Membranes - Garland Science 2016, ISBN 978-0-8153-4196-3
- Yves Dufrene (Ed.): Life at the Nanoscale - Pan Stanford Publishing 2011, ISBN 978-981-4267-96-0

Language:

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

Notes:

Prerequisites for attending the module:
- None

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

ME4260 T - Module part: Theoretical Biophysics (TheoBiophy)

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

Course of study, specific field and term:

- Master MES 2020 (module part), mathematics / natural sciences, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master MES 2014 (module part), mathematics / natural sciences, Arbitrary semester

Classes and lectures:

- Theoretical Biophysics (lecture, 2 SWS)
- Theoretical Biophysics (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Basic concepts of quantum mechanics
- Intra- and intermolecular interactions
- Description of molecules by classical models
- Simulation of the dynamics of molecules by means of Newtonian mechanics
- Description of molecular dynamics with the help of thermodynamics

Qualification-goals/Competencies:

- Students can explain how the existence of atoms and molecules can be explained from the fundamental assumptions of quantum mechanics.
- They can explain, within what limits can be described by classical models the interactions between atoms.
- They can sketch an algorithm with which the dynamics of molecules can be simulated.
- They can list, which thermodynamic concepts are to describe the molecular dynamics.

Grading through:

- Oral examination

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute of Physics
- PD Dr. rer. nat. Hauke Paulsen

Literature:

- V. Schünemann: Biophysik - Berlin: Springer 2004
- M. Daune: Molekulare Biophysik - Braunschweig: Vieweg 1997

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

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

ME4411 T - Module part: Computed Tomography (CT)

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

Course of study, specific field and term:

- Master CLS 2023 (Module part of a compulsory module), MML with specialization in Image Processing, 1st semester
- Master MES 2020 (Module part of a compulsory module), medical engineering science, 1st semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master CLS 2016 (Module part of a compulsory module), MML with specialization in Image Processing, 1st semester
- Master Computer Science 2014 (module part), Module part, Arbitrary semester
- Master Medical Informatics 2014 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master MES 2014 (Module part of a compulsory module), medical engineering science, 1st semester

Classes and lectures:

- Computed Tomography (lecture, 2 SWS)

Workload:

- 40 Hours private studies
- 35 Hours in-classroom work
- 15 Hours exam preparation

Contents of teaching:

- Signal processing (recapitulation of fundamental principles in signal processing)
- Mathematical methods in image reconstruction and signal processing
- X-Ray (fundamental principles, quantum statistics)
- Computed Tomography * devices, * current and past technology, * signal processing, * Fourier-based 2D and 3D image reconstruction, * algebraic and statistical image reconstruction, * image artifacts, * technical and clinical applications, * dose.

Qualification-goals/Competencies:

- Students are able to create an overview of the signal chain for medical imaging.
- They are able to explain the mathematical background for the reconstruction of CT images.
- They are able to explain the basics for the creation of X-ray.
- They are able to list all generations of CT devices and explain differences and advances.
- They are able to apply the Fourier transform.
- They are able to explain the mathematical basics for the two-dimensional image reconstruction.
- They are able to create and apply an algebraic approach for the reconstruction of CT images.
- They are able to create and apply an statistical approach for the reconstruction of CT images.
- They are able to outline the differences between two dimensional and three dimensional image reconstruction.
- They are able to transfer methods from two dimensional to three dimensional image reconstruction.

Grading through:

- Oral examination

Responsible for this module:

- Siehe Hauptmodul

Teacher:

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

Literature:

- T. M. Buzug: Computed Tomography, From Photon Statistics to Modern Cone Beam CT - Springer-Verlag, Berlin/Heidelberg, 2008
- T. M. Buzug: Einführung in die Computertomographie, Mathematisch-physikalische Grundlagen der Bildrekonstruktion - Springer-Verlag, Berlin/Heidelberg, 2004

Language:

- German and English skills required

Notes:

Prerequisites for attending the module:
- None

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

Module exam(s):
- ME4411-L1: Computed Tomography, oral exam, 100 % of module grade

(Is module part of CS4512, ME4410-KP12, ME4415-KP06)

ME4412 T - Module part: Magnetic Resonance Imaging (MRT)

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

Course of study, specific field and term:

- Master CLS 2023 (Module part of a compulsory module), MML with specialization in Image Processing, 1st semester
- Master MES 2020 (Module part of a compulsory module), medical engineering science, 1st semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master Medical Informatics 2019 (module part), Module part, Arbitrary semester
- Master CLS 2016 (Module part of a compulsory module), MML with specialization in Image Processing, 1st semester
- Master Computer Science 2014 (module part), Module part, Arbitrary semester
- Master Medical Informatics 2014 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master MES 2014 (Module part of a compulsory module), medical engineering science, 1st semester

Classes and lectures:

- Magnetic Resonance Imaging (lecture, 2 SWS)

Workload:

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

Contents of teaching:

- Physical fundamentals of magnetic resonance imaging: nuclear magnetic resonance, relaxation mechanisms, principles of position encodingprinciples of spatial encoding, relaxation)
- Construction of basic imaging sequences, weighting
- Concept of k-space
- Coherence pathways
- Hardware components of a clinical MR system
- Possible sources of hazard for patients
- Influence of measurement parameters on signal-to-noise ratio
- Causes of image artefacts

Qualification-goals/Competencies:

- The students can explain the physical principles of NMR and MRI.
- They can explain the idea behind important imaging sequences, using a pulse sequence diagram.
- They can recognise the causes of important image artefacts.
- The can list advantages and disadvantages of MRT, compared to other imaging techniques.
- They can list possible sources of hazard for patients, explain their causes and point out strategies for avoiding these.

Grading through:

- Oral examination

Responsible for this module:

- Siehe Hauptmodul

Teacher:

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

Literature:

- Liang, Z.-P., Lauterbur, P. C.: Principles of Magnetic Resonance Imaging: A Signal Processing Perspective - IEEE Press, New York 2000

Language:

- German and English skills required

Notes:

Prerequisites for attending the module:
- None

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

Module exam(s):
- ME4412-L1: Magnetic Resonance Imaging, oral exam, 30 min, 100 % of module grade

(Is module part of CS4512, ME4410-KP12, ME4415-KP06, ME4414-KP06)

ME4413 T - Module part: Nuclear Imaging (Nukl)

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

Course of study, specific field and term:

- Master MES 2020 (Module part of a compulsory module), medical engineering science, 2nd semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master Medical Informatics 2019 (module part), Module part, Arbitrary semester
- Master Computer Science 2014 (module part), Module part, Arbitrary semester
- Master Medical Informatics 2014 (module part), Module part, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master MES 2014 (Module part of a compulsory module), medical engineering science, 2nd semester

Classes and lectures:

- Nuclear Imaging (lecture, 2 SWS)

Workload:

- 40 Hours private studies
- 35 Hours in-classroom work
- 15 Hours exam preparation

Contents of teaching:

- Physical, biological and medical basics of nuclear imaging
- Scintigraphy
- Positron emission tomography (PET)
- Single photon emission computed tomography (SPECT)
- Clinical and preclinical applications

Qualification-goals/Competencies:

- Students are able to explain the physical principles and phenomena of nuclear imaging.
- They can describe relevant phenomena and procedures mathematically.
- They can understand the basics of nuclear medicine.
- They can explain the applications of nuclear imaging techniques.
- They can name and explain the advantages and disadvantages and limitations of nuclear imaging methods.

Grading through:

- Oral examination

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute of Medical Engineering
- Prof. Dr. rer. nat. Magdalena Rafecas

Literature:

- S. R. Cherry, J. A. Sorenson, M. E. Phelps: Physics in Nuclear Medicine - Elsevier, 2012
- M. N. Wernick, J. N. Aarsvold: Emission Tomography: The Fundamentals of PET and SPECT - Elsevier, 2004
- D. L. Bailey, D. W. Townsend, P. E. Valk , M N. Maisey (Editors): Positron Emission Tomography: Basic Sciences - Springer, 2005

Language:

- offered only in English

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Preliminary examinations can be determined at the beginning of the semester. If preliminary work has been defined, it must have been

completed and positively assessed before the initial examination.

ME4421 T - Module part: Biomedical Optics 1 (BioMedOp1)

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

Course of study, specific field and term:

- Master MES 2020 (Module part of a compulsory module), medical engineering science, 1st semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master Biophysics 2019 (Module part of a compulsory module), biophysics, 1st semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master MES 2014 (Module part of a compulsory module), medical engineering science, 1st semester
- Master Biophysics 2023 (Module part of a compulsory module), biophysics, 1st semester

Classes and lectures:

- Lecture Biomedical Optics 1 (lecture, 2 SWS)

Workload:

- 40 Hours private studies and exercises
- 30 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- Tissue optics
- Photophysics of molecules, fluorescent markers, and targeting
- Photochemistry, photobiology, and photodynamic therapy
- Spectroscopic tissue characterization and diagnosis
- Raman spectroscopy and imaging
- Coherence of light, and implications for biomedical optics
- Generation, steering, and detection of light
- Thermal action of light on biomolecules and tissue, rate processes
- Selective treatment of ocular structures, guided by online-dosimetry
- Mechanisms of pulsed laser ablation
- Laser ablation at tissue surfaces and inside the body & surgery by high-intensity focused ultrasound
- Nonlinear interactions of light and matter
- Plasma-mediated surgery, exemplified on refractive corneal surgery and cataract surgery
- Optical manipulation of microstructures (Laser scissors, tweezers, and catapults)
- Plasmonic systems, nano-optics, and optical bio-sensors

Qualification-goals/Competencies:

- The students are able to describe, illustrate and compare the fundamental diagnostic and therapeutic optical techniques in biomedicine.
- They are able to assess advantages and disadvantages of these techniques and to draw conclusions for their implementation into possible applications.
- They can explain light and tissue interactions and relate them to the optical techniques in which they are used.
- The students are able to understand and classify complex optical techniques as a whole and to analyze their constitutents.
- They have a profound understanding of scientific optical techniques in biomedicine, can apply it independently, and are able to transfer their knowledge to related tasks.

Grading through:

- exam type depends on main module

Is requisite for:

- Module part: Biomedical Optics 2 (ME4422 T)

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute of Biomedical Optics
- Prof. Dr. rer. nat. Robert Huber
- Prof. Dr. rer. nat. Gereon Hüttmann

- Dr. rer. nat. Ralf Brinkmann
- Dr. rer. nat. Norbert Linz

Literature:

- P.N. Prasad: Introduction to Biophotonics - Wiley 2003
- J. Popp, V. Tuchin, A. Chiou, S.H. Heinemann: Handbook of Biophotonics Vol 1 & 2 - Wiley-VCH 2011
- A.J. Welch, M. van Gemert: Optical-Thermal Response of Laser-Irradiated Tissue - Plenum 1995 (zweite Auflage 2011)

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

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

ME4422 T - Module part: Biomedical Optics 2 (BioMedOp2)

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

Course of study, specific field and term:

- Master MES 2020 (Module part of a compulsory module), medical engineering science, 2nd semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master Biophysics 2019 (Module part of a compulsory module), biophysics, 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master MES 2014 (Module part of a compulsory module), medical engineering science, 2nd semester
- Master Biophysics 2023 (Module part of a compulsory module), biophysics, 2nd semester

Classes and lectures:

- Biomedical Optics 2 (lecture, 2 SWS)

Workload:

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

Contents of teaching:

- Light microscopy: geometrical optics, wave optics, Fourier optics
- Effects of incoherent and coherent microscope-illumination & technical realization
- Phase contrast and differential interference contrast (DIC)
- Marker and targeting techniques, GFP, quantum dots, FRET
- Deconvolution & optical sectioning via structured illumination, confocal microscopy, 2-photon imaging
- Nanoscopy beyond the Abbe-limit: principles and biological applications
- Optical coherence tomography (OCT): principles, technical realization, and clinical applications
- Opto-acoustic tomography and microscopy
- Electron microscopy: principles and biological applications of TEM, REM, and Cryo-EM

Qualification-goals/Competencies:

- The students have a profound understanding and knowledge of modern optical imaging techniques in biomedicine, are able to describe and illustrate them, and to relate them to applications.
- They can explain the light-tissue interaction relevant for the different techniques, describe them mathematically and predict their effects.
- The students are able to understand and classify complex optical imaging techniques as a whole and to analyze their constitutents.
- They are able to transfer and adopt their knowledge to related problems and to develop new concepts.

Grading through:

- exam type depends on main module

Requires:

- Module part: Biomedical Optics 1 (ME4421 T)

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute of Biomedical Optics

- Prof. Dr. rer. nat. Robert Huber
- Prof. Dr. rer. nat. Gereon Hüttmann
- Prof. Dr. rer. nat. Sebastian Karpf
- Dr. rer. nat. Norbert Linz
- Dr. rer. nat. Ralf Brinkmann

Literature:

- D. B. Murphy: Fundamentals of Light Microscopy and Electronic Imaging - Wiley-Liss 2001
- J. Mertz: Optical Microscopy - Roberts & Co. Publ. 2010
- J.B. Pawley (ed): Handbook of Confocal Microscopy - Springer 2006

- W. Drexler, J.G. Fujimoto (eds.): Optical Coherence Tomography - Springer 2008
- L. Wang (ed): Photoacoustic Imaging and Spectroscoy - CRC Press 2009

Language:

- offered only in German

Notes:

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

Prerequisites for the exam:
- Talk and participation in discussion

ME4423 T - Module part: Laserphysics and -technologies (LaPhyTec)

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

Course of study, specific field and term:

- Master MES 2020 (Module part of a compulsory module), medical engineering science, 1st semester
- Master Entrepreneurship in Digital Technologies 2020 (module part), Module part, Arbitrary semester
- Master Biophysics 2019 (Module part of a compulsory module), biophysics, 1st semester
- Master Entrepreneurship in Digital Technologies 2014 (module part), Module part, Arbitrary semester
- Master MES 2014 (Module part of a compulsory module), medical engineering science, 1st semester
- Master Biophysics 2023 (Module part of a compulsory module), biophysics, 1st semester

Classes and lectures:

- Lecture laser physics and -technologies (lecture, 2 SWS)

Workload:

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

Contents of teaching:

- Understanding the laser (What is a laser, the laser history, laser parameters)
- Basic properties of light, light propagation (Gaussian beam resonators, stability conditions, wavelength selective elements)
- Light and matter (radiation interactions, stimulated and spontaneous emission light amplification)
- Laser (Broad laser theory, rate equations, laser threshold, laser dynamics)
- Types of lasers (gas lasers, ion lasers, solid state lasers, fiber lasers, semiconductor lasers)
- nonlinear optics (frequency doubling and conversion)
- Ultrashort light pulses

Qualification-goals/Competencies:

- Students can assess what types of lasers are suitable for which applications.
- They can implement concepts for new laser applications.
- They can list the most important types of lasers.
- They can explain the basic concepts of laser physics.
- They can analyze laser formally.
- They can assess the potential of laser radiation on the basis of the parameters.

Grading through:

- exam type depends on main module

Responsible for this module:

- Siehe Hauptmodul

Teacher:

- Institute of Biomedical Optics
- Prof. Dr. rer. nat. Robert Huber
- Dr. rer. nat. Ralf Brinkmann
- Prof. Dr. rer. nat. Sebastian Karpf

Literature:

- Dieter Meschede: Optics, Light and Lasers - Wiley-VCH 2007
- Walter Koechner: Solid State Laser Engineering - Springer 1999
- Saleh/Teich: Grundlagen der Photonik - Wiley-VCH 2008

Language:

- offered only in German

Notes:

Prerequisites for attending the module:
- None

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

CS4160-KP06, CS4160SJ14 - Real-Time Systems (Echtzeit14)

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

Course of study, specific field and term:

- Master MES 2020 (optional subject), computer science / electrical engineering, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester
- Master Computer Science 2019 (basic module), technical computer science, 1st or 2nd semester
- Master Medical Informatics 2019 (optional subject), technical computer science, 1st or 2nd semester
- Master IT-Security 2019 (basic module), technical computer science, 1st or 2nd semester
- Master MES 2014 (optional subject), computer science / electrical engineering, 1st semester
- Master Medical Informatics 2014 (basic module), computer science, 1st or 2nd semester
- Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (basic module), specific, 1st or 2nd semester
- Master Computer Science 2014 (basic module), technical computer science, 1st or 2nd semester

Classes and lectures:

- Real-Time Systems (lecture, 2 SWS)
- Real-Time Systems (exercise, 2 SWS)

Workload:

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

Contents of teaching:

- Real-time processing (definitions, requirements)
- Process automation systems
- Real-time programming
- Process connectivity and networking
- Modelling of discrete event systems (automata, state charts)
- Modelling of continuous systems (differential equations, Laplace transformation)
- Application of design tools (Matlab/Simulink, Stateflow)

Qualification-goals/Competencies:

- The students are able to describe the fundamental problems of real-time processing.
- They are able to explain real-time computer systems for process automation, in particular SPS.
- They are able to program real-time systems in the IEC languages.
- They are able to elucidate process interfaces and real-time bus system.
- They are able to model, analyze and implement event discrete systems, in particular process control systems.
- They are able to model, analyze and implement continuous systems, in particular feedback control systems.
- They are able to make use of design tools for real-time systems.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr.-Ing. Mladen Berekovic

Teacher:

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

Literature:

- R. C. Dorf, R. H. Bishop: Modern Control Systems - Prentice Hall 2010
- L. Litz: Grundlagen der Automatisierungstechnik - Oldenbourg 2012
- M. Seitz: Speicherprogrammierbare Steuerungen - Fachbuchverlag Leipzig 2012
- H. Wörn, U. Brinkschulte: Echtzeitsysteme - Berlin: Springer 2005
- S. Zacher, M. Reuter: Regelungstechnik für Ingenieure - Springer-Vieweg 2014

Language:

- offered only in English

Notes:

Admission requirements for taking the module:
- None

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

Module Exam(s):
- CS4160-L1: Real-Time Systems, written exam, 90min, 100% of the module grade

CS4170-KP06, CS4170SJ14 - Parallel Computer Systems (ParaRSys14)

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

Course of study, specific field and term:

- Certificate in Artificial Intelligence (compulsory), Artificial Intelligence, 1st semester
- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master Computer Science 2019 (basic module), technical computer science, 1st or 2nd semester
- Master Medical Informatics 2019 (optional subject), technical computer science, 1st or 2nd semester
- Master Robotics and Autonomous Systems 2019 (optional subject), Elective, 1st or 2nd semester
- Master IT-Security 2019 (basic module), technical computer science, 1st or 2nd semester
- Master Medical Informatics 2014 (basic module), computer science, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (basic module), specific, 1st or 2nd semester
- Master Computer Science 2014 (basic module), technical computer science, 1st or 2nd semester

Classes and lectures:

- Parallel Computer Systems (lecture, 2 SWS)
- Parallel Computer Systems (exercise, 2 SWS)

Workload:

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

Contents of teaching:

- Motivation and limitations for parallel processing
- Parallel computing models
- Taxonomy of parallel computers
- Multi/manycore-systems
- Graphic Processing Units (GPUs)
- OpenCL
- Specification languages
- Hardware architectures
- System management of many-core systems

Qualification-goals/Competencies:

- Students are able to characterize different parallel computing architectures.
- They are able to explain models of parallel computing.
- They are able to make use of common programming interfaces for parallel computing systems.
- They are able to judge which kind of parallel computing system is best suited for a dedicated problem and how many cores should be used.
- They are able to evaluate the pros and cons of different hardware architectures.
- They are able to write programs for parallel computing systems under considerations of the underlying hardware architecture.
- They are able to compare methods for dynamic voltage and frequency scaling (DVFS) for manycore systems.

Grading through:

- written exam

Responsible for this module:

- Prof. Dr.-Ing. Mladen Berekovic

Teacher:

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

Literature:

- G. Bengel, C. Baun, M. Kunze, K. U. Stucky: Masterkurs Parallele und Verteilte Systeme - Vieweg + Teubner, 2008
- M. Dubois, M. Annavaram, P. Stenström: Parallel Computer Organization and Design - University Press 2012
- B. R. Gaster, L. Howes, D. R. Kaeli, P. Mistry, D. Schaa: Heterogeneous Computing with OpenCL - Elsevier/Morgan Kaufman 2013
- B. Wilkinson; M. Allen: Parallel Programming - Englewood Cliffs: Pearson 2005
- J. Jeffers, J. Reinders: Intel Xeon Phi Coprozessor High-Performance Programming - Elsevier/Morgan Kaufman 2013

- D. A. Patterson, J. L. Hennessy: Computer Organization and Design - Morgan Kaufmann, 2013

Language:

- offered only in German

Notes:

Admission requirements for taking the module:
- None

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

Module Exam(s):
- CS4170-L1: Parallel Computer Systems, oral exam, 100% of the module grade

CS4501-KP12, CS4501 - Algorithmics, Logic and Computational Complexity (ALK14)

Duration:	Turnus of offer:	Credit points:
2 Semester	each summer semester	12

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master Computer Science 2019 (optional subject), advanced module, Arbitrary semester
- Master IT-Security 2019 (advanced module), Elective Computer Science, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (advanced module), specific, 2nd and/or 3rd semester
- Master Computer Science 2014 (advanced module), advanced curriculum, 2nd and/or 3rd semester

Classes and lectures:

- Algorithmics, Logic and Computational Complexity (lecture, 4 SWS)
- Algorithmics, Logic and Computational Complexity (exercise, 2 SWS)
- Seminar Algorithmics, Logic and Computational Complexity (seminar, 2 SWS)

Workload:

- 160 Hours private studies and exercises
- 120 Hours in-classroom work
- 40 Hours exam preparation
- 40 Hours work on an individual topic with written and oral presentation

Contents of teaching:

- recent results in algorithmics and complexity theory
- communication and circuit complexity
- structural and descriptive complexity theory
- algorithmic game theory
- nonstandard computing models
- understanding logics as a tool

Qualification-goals/Competencies:

- the students can demonstrate a deep knowledge of concepts and methods for algorithm design and complexity analysis.
- They are able to classify algorithmic problems and to select appropriate strategies for their solution
- They are able to model complex problem settings appropriately.
- They can assess and explain the importance of lower bounds for applications.

Grading through:

- Oral examination

Requires:

- Algorithmics (CS4000-KP06, CS4000SJ14)

Responsible for this module:

- Prof. Dr. Kim-Manuel Klein

Teacher:

- Institute for Theoretical Computer Science
- Prof. Dr. Rüdiger Reischuk
- Prof. Dr. rer. nat. Till Tantau
- Prof. Dr. Maciej Liskiewicz
- Prof. Dr. Kim-Manuel Klein

Literature:

- R. Reischuk: Einführung in die Komplexitätstheorie - Teubner, 1990
- S. Arora, B. Barak: Computational Complexity - Cambridge UP 2009
- C. Papadimitriou: Computational Complexity - Addison-Wesley, 1994
- M. Huth, M. Ryan: Logic in Computer Science - Cambridge University. Press 2004
- D. Kozen: Theory of Computation - Springer, 2006

Language:

- German and English skills required

Notes:

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

CS4503-KP12, CS4503 - Ambient Computing and Applications (AmbCompA)

Duration:	Turnus of offer:	Credit points:
2 Semester	normally each year in the summer semester	12

Course of study, specific field and term:

- Master Robotics and Autonomous Systems 2019 (advanced module), advanced curriculum, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master Computer Science 2019 (optional subject), advanced module, Arbitrary semester
- Master IT-Security 2019 (advanced module), Elective Computer Science, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (advanced module), specific, 2nd and/or 3rd semester
- Master Computer Science 2014 (advanced module), advanced curriculum, 2nd and/or 3rd semester

Classes and lectures:

- CS4670 T: Ambient Computing (lecture, 3 SWS)
- Seminar Ambient Computing (seminar, 2 SWS)
- Lab Course Ambient Computing (project work, 3 SWS)

Workload:

- 120 Hours group work
- 120 Hours in-classroom work
- 70 Hours private studies
- 30 Hours oral presentation (including preparation)
- 20 Hours exam preparation

Contents of teaching:

- Ambient Computing:
- Current paradigms in computer technology
- Smart components
- Software architectures
- Context-sensitive systems
- Ambient Intelligence
- Interactive ambient media systems
- Ambient Computing Applications (AAL)
- Ethical, Legal and Social Implications (ELSI)

Qualification-goals/Competencies:

- Ambient Computing:
- The students are able to evaluate possibilities, concepts and challenges of Ambient Systems
- They have an overview about current technologies and systems for developing Ambient Systems
- They are able to follow and judge state-of-the-art research in the area of Ambient Computing

Grading through:

- portfolio exam

Responsible for this module:

- Prof. Dr.-Ing. Andreas Schrader

Teacher:

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

Literature:

- John Krumm: Ubiquitous Computing Fundamentals - CRC Press, 2009
- Stefan Poslad: Ubiquitous Computing: Smart Devices, Environments and Interactions - Wiley, 2009

Language:

- German and English skills required

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of the project assignment as specified at the beginning of the semester.
- Seminar lecture with elaboration according to the requirements at the beginning of the semester

Module Exam(s):
- CS4503-L1: Ambient Computing and Applications, Portfolio exam consisting of: 20 points in the form of a seminar paper with presentation, 20 points in the form of a project paper and 60 points in the form of an oral exam, 100% of module grade.

(Consists of CS4670 T)

(share of Institute of Telematics in S is 100%)
(share of Institute of Telematics in P is 100%)

CS4504-KP12, CS4504 - Cyber Physical Systems (CPS)

Duration:	Turnus of offer:	Credit points:
2 Semester	each year, can be started in winter or summer semester	12

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master Computer Science 2019 (optional subject), advanced module, Arbitrary semester
- Master Robotics and Autonomous Systems 2019 (advanced module), advanced curriculum, 1st or 2nd semester
- Master IT-Security 2019 (advanced module), Elective Computer Science, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (advanced module), specific, 2nd and/or 3rd semester
- Master Computer Science 2014 (advanced module), advanced curriculum, 2nd and/or 3rd semester

Classes and lectures:

- CS5150 T: Organic Computing (lecture with exercises, 3 SWS)
- CS5153 T: Wireless Sensor Networks (lecture with exercises, 3 SWS)
- CS4504-S: Cyber Physical Systems (seminar, 2 SWS)

Workload:

- 220 Hours private studies
- 120 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- basic principles of organic computing / self-x system properties
- from motion to intelligent behavior and system/machine behavior
- design for self-organization, robustness, adaptivity, flexibility, trust
- analyzing, reverse-engineering, debugging machine behavior
- designing experiments and measuring behavior
- modeling system/machine behavior
- complexity, opacity, obscurity, trust of (AI) systems and explainable AI
- architecture of organic computing systems
- applications of self-x systems
- basics of wireless sensor networks
- hardware aspects of sensor nodes
- physics and protocols of wireless communication
- routing in wireless networks
- time synchronization and localization in wireless networks
- data management and data processing in wireless sensor networks
- applications of wireless sensor networks

Qualification-goals/Competencies:

- Students are able to utilize the principles of organic computing/self-x systems on exemplary designs.
- They are able to explain principles of organic computing/self-x systems.
- They are able to analyze system/machine behaviors in a structured, sound approach.
- Students are able to present the pros and cons of sensor networks.
- They are able to cope with analysis, design, and evaluation of protocols in sensor networks.
- They are able to interpret and pursue current research activities for sensor networks.

Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr.-Ing. Mladen Berekovic

Teacher:

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

Literature:

- C. Müller-Schloer, S. Tomforde: Organic Computing Technical Systems for Survival in the Real World - Birkhäuser, 2017
- H. Karl, A. Willig: Protocols and Architectures of Wireless Sensor Networks - Wiley, 2005

Language:

- offered only in English

Notes:

Admission requirements for taking the module:
- None

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

Module Exam(s):
- CS4504-L1: Cyber Physical Systems, oral exam, 100% of the module grade.

(Consists of CS5150 T, CS5153 T)

CS4505-KP12, CS4505 - System Architecture (SysArch)

Duration:	Turnus of offer:	Credit points:
2 Semester	each year, can be started in winter or summer semester	12

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master Computer Science 2019 (optional subject), advanced module, Arbitrary semester
- Master IT-Security 2019 (advanced module), Elective Computer Science, 1st or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (advanced module), specific, 2nd and/or 3rd semester
- Master Computer Science 2014 (advanced module), advanced curriculum, 2nd and/or 3rd semester

Classes and lectures:

- Computer-Aided Design of Digital Circuits (s. CS3110 T) (lecture with exercises, 3 SWS)
- Hardware/Software Co-Design (s. CS5170 T) (lecture with exercises, 3 SWS)
- Lab course System Architecture or Seminar System Architecture (practical course, 3 SWS)

Workload:

- 195 Hours private studies
- 135 Hours in-classroom work
- 30 Hours exam preparation

Contents of teaching:

- see module parts

Qualification-goals/Competencies:

- see module parts

Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr.-Ing. Mladen Berekovic

Teacher:

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

Literature:

- :

Language:

- German and English skills required

Notes:

Admission requirements for taking the module:
- None

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

Module Exam(s):
- CS4505-L1: System Architecture, oral exam, 100% of the module grade.

A seminar can also be offered instead of the internship.

CS4506-KP12, CS4506 - Information and Communication Security (SDK)

Duration:	Turnus of offer:	Credit points:
2 Semester	each year, can be started in winter or summer semester	12

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master Computer Science 2019 (optional subject), advanced module, Arbitrary semester
- Master Computer Science 2014 (compulsory), specialization field IT security and safety, 1st and 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (advanced module), specific, 2nd and 3rd semester
- Master Computer Science 2014 (advanced module), advanced curriculum, 2nd and 3rd semester

Classes and lectures:

- Cryptographic Protocols (lecture, 3 SWS)
- Cryptographic Protocols (exercise, 1,5 SWS)
- Modeling and Analysing Security (seminar, 3 SWS)
- Modeling and Analysing Security (practical course, 1 SWS)
- Modeling and Analysing Security (exercise, 1 SWS)

Workload:

- 170 Hours private studies
- 150 Hours in-classroom work
- 40 Hours exam preparation

Contents of teaching:

- see module parts CS4211T and CS4210T
-
-
-
-
- Modelling and formalizing protocols and security properties
- Adversaries and models of attacks, security pitfalls
- Symbolic methods and automatic verification of security properties
- Consistency and synchronization

Qualification-goals/Competencies:

- The students can comprehensively explain the security challenges of of digital communication.
- They can reason about cryptographic methods and their application in communication systems.
- The are able to select suitable security primitives for given applications and to implement them.
- The can conduct a security analysis of communication protocols.
- They can designate the weaknesses of real systems and evaluate them.
- The students can comprehensively elaborate on algorithmic basics for IT security.
- They can report on security properties.
- They can recite complex methods for IT security and apply them.
- They are able to specify, analyse and verify protocols and security properties.
- They can describe techniques for automatic verification of security properties.

Grading through:

- Oral examination

Requires:

- Cryptology (CS4016)
- Security in Networks and Distributed Systems (CS4180-KP04, CS4180)

Responsible for this module:

- Prof. Dr. Rüdiger Reischuk

Teacher:

- Institute for Theoretical Computer Science

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

Literature:

- V. Cortier, S. Kremer (Ed.): Formal Models and Techniques for Analyzing Security Protocols - Cryptology and Information Security Series 5, IOS Press, 2011
- C. Pfleeger, S. Pfleeger: Security in Computing - Prentice-Hall 2007
- A. Joux: Algorithmic Cryptanalysis - CRC Press 2009
- J. Katz, Y. Lindell: Introduction to Modern Cryptography - CRC Press 2014
- S. Loepp, W. Wootters: Protecting Information - Cambridge Univ. Press 2006
- Lindell: Tutorials on the Foundations of Cryptography - Springer 2017
- Goldreich: Fundamentals of Cryptography - Cambridge Univ. Press 2004
- I. Cox, M. Miller, J. Bloom, J. Fridrich, T. Kalkerm: Digital Watermarking and Steganography - Morgan Kaufmann 2008
- Dwork, Roth: The Algorithmic Foundations of Differential Privacy - 2014

Language:

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

Notes:

Prerequisites for attending the module:
- None

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

CS4507-KP12, CS4507 - Software Verification (SoftVeri)

Duration:	Turnus of offer:	Credit points:
2 Semester	each year, can be started in winter or summer semester	12

Course of study, specific field and term:

- Master Computer Science 2019 (compulsory), Canonical Specialization SSE, Arbitrary semester
- Master MES 2020 (advanced module), computer science / electrical engineering, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master Computer Science 2019 (optional subject), advanced module, Arbitrary semester
- Master Computer Science 2014 (compulsory), specialization field software systems engineering, 1st and 2nd semester
- Master MES 2014 (advanced module), computer science / electrical engineering, 1st and 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (advanced module), specific, 2nd and 3rd semester
- Master Computer Science 2014 (advanced module), advanced curriculum, 2nd and 3rd semester

Classes and lectures:

- CS4138 T: Model Checking (lecture with exercises, 4 SWS)
- CS4139 T: Runtime Verification and Testing (lecture with exercises, 4 SWS)
- CS5220 T: Static Analysis (lecture with exercises, 4 SWS)

Workload:

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

Contents of teaching:

- see module parts

Qualification-goals/Competencies:

- The students can relate different approaches to software verification.
- For further competencies see module parts

Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr. Martin Leucker

Teacher:

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

Literature:

- : see module parts

Language:

- German and English skills required

Notes:

(The module consists of CS4138 T, CS4139 T and CS5220 T)

2 of the 3 module parts must be chosen.

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- depending on the module parts

CS4508-KP12, CS4508 - Data Management (DatManag)

Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	12

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master Computer Science 2019 (optional subject), advanced module, Arbitrary semester
- Master IT-Security 2019 (advanced module), Elective Computer Science, 1st or 2nd semester
- Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (advanced module), specific, 2nd or 3rd semester
- Master Computer Science 2014 (advanced module), advanced curriculum, 2nd or 3rd semester

Classes and lectures:

- CS4140 T: Mobile and distributed information systems (lecture with exercises, 3 SWS)
- CS5140 T: Semantic Web (lecture with exercises, 3 SWS)
- Seminar data management (seminar, 2 SWS)

Workload:

- 130 Hours private studies
- 120 Hours in-classroom work
- 90 Hours work on an individual topic with written and oral presentation or group work
- 20 Hours exam preparation

Contents of teaching:

- see module parts

Qualification-goals/Competencies:

- see module parts

Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr. Sven Groppe

Teacher:

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

Literature:

- : see module parts

Language:

- German and English skills required

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of the project assignment as specified at the beginning of the semester or
- Seminar lecture with elaboration according to the requirements at the beginning of the semester.

Module Exam(s):
- CS4508-L1: Data Management, oral exam, 100% of the module grade.

Instead of the seminar, an internship can also be offered.

(Consists of CS4140 T, CS5140 T)

CS4509-KP12, CS4509 - Internet Structures and Protocols / Internet Technologies (Internet)

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

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master Computer Science 2019 (optional subject), advanced module, Arbitrary semester
- Master IT-Security 2019 (advanced module), Elective Computer Science, 1st or 2nd semester
- Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (advanced module), specific, 2nd and 3rd semester
- Master Computer Science 2014 (advanced module), advanced curriculum, 2nd and 3rd semester

Classes and lectures:

- Architectures for Distributed Applications (lecture with exercises, 3 SWS)
- Advanced Internet Technologies (lecture with exercises, 3 SWS)
- Software Architectures (project work, 3 SWS)

Workload:

- 120 Hours in-classroom work
- 105 Hours private studies
- 45 Hours work on project
- 45 Hours group work
- 45 Hours exam preparation

Contents of teaching:

- see module parts

Qualification-goals/Competencies:

- see module parts

Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr. Stefan Fischer

Teacher:

- Institute of Telematics
- Prof. Dr.-Ing Horst Hellbrück
- Prof. Dr.-Ing. habil. Dennis Pfisterer

Literature:

- : see module parts

Language:

- German and English skills required

Notes:

(Consists of CS5158 T, CS4151 T).

As of winter semester 2019/20, the module has been renamed from Internet Technologies to Internet Structures and Protocols.

As of winter semester 2020/21, the module is no longer offered to new students.

Admission requirements for taking the module:
- None

Admission requirements for taking module examination(s):
- Successful participation in lab

CS4510-KP12, CS4510 - Signal Analysis (SignalAna)

Duration:	Turnus of offer:	Credit points:
2 Semester	each year, can be started in winter or summer semester	12

Course of study, specific field and term:

- Master Biophysics 2023 (advanced module), advanced curriculum, 1st or 2nd semester
- Master MES 2020 (advanced module), computer science / electrical engineering, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master Computer Science 2019 (optional subject), advanced module, Arbitrary semester
- Master Biophysics 2019 (advanced module), advanced curriculum, 1st and 2nd semester
- Master IT-Security 2019 (advanced module), Elective Computer Science, 1st or 2nd semester
- Master MES 2014 (advanced module), computer science / electrical engineering, 1st and/or 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (advanced module), specific, 2nd and/or 3rd semester
- Master Computer Science 2014 (advanced module), advanced curriculum, 2nd and/or 3rd semester

Classes and lectures:

- CS5260SJ14 T: Speech and Audio Signal Processing (lecture with exercises, 3 SWS)
- CS5275 T: Selected Topics of Signal Analysis and Enhancement (lecture with exercises, 3 SWS)
- CS5194 T: Lab course (project work, 3 SWS)

Workload:

- 150 Hours private studies
- 90 Hours in-classroom work
- 60 Hours group work
- 40 Hours exam preparation
- 20 Hours written report

Contents of teaching:

- Introduction to statistical signal analysis
- Principles of feature extraction and pattern recognition
- Linear optimum filters
- Adaptive filters
- Spectrum analysis
- Basic concepts of multirate signal processing
- Applications in speech and image processing
- Realization of signal processing tasks for typical application scenarios in teamwork

Qualification-goals/Competencies:

- Students are able to explain the basic elements of stochastic signal processing and optimum filtering.
- They are able to describe and apply linear estimation theory.
- Students are able to describe the concepts of adaptive signal processing.
- They are able to explain theconcepts of feature extraction and pattern recognition.
- They are able to analyze and design multirate systems.
- Students are able to explain various practical applications of signal processing algorithms.
- They are able to create and implement signal processing systems on their own and in teamwork.

Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr.-Ing. Markus Kallinger

Teacher:

- Institute for Signal Processing
- Prof. Dr.-Ing. Markus Kallinger

Literature:

- : See description of module parts

Language:

- German and English skills required

Notes:

Examination prerequisites can be defined at the beginning of the semester. If preliminary work is defined, it must have been completed and positively evaluated before the first examination.

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- CS4510-L3 (all exept Master Biophysics since 2023): Successful completion of the project assignment, seminar presentation and exercise assignments as specified at the beginning of the semester
- CS4510-L1 (only Master Biophysics since 2023): Successful completion of the exercise assignments as specified at the beginning of the semester
- CS4510-L2 (only Master Biophysics since 2023): Successful completion of the project assignment as specified at the beginning of the semester

Module Exam(s):
- CS4510-L3 (all exept Master Biophysics since 2023): Signal Analysis, oral exam, 100% of module grade
- CS4510-L1 (only Master Biophysics since 2023): partial exam Signal Analyse, oral exam, 100% of module grade
- CS4510-L2 (only Master Biophysics since 2023): partial exam Lab course Signal- and image processing, project, ungraded

(Consists of CS4220 T, CS5275 T, CS5194 T)

CS4511-KP12, CS4511 - Learning Systems (LernSys)

Duration:	Turnus of offer:	Credit points:
2 Semester	irregularly	12

Course of study, specific field and term:

- Master Biophysics 2023 (advanced module), advanced curriculum, 1st or 2nd semester
- Master Computer Science 2019 (optional subject), Canonical Specialization Bioinformatics and Systems Biology, Arbitrary semester
- Master MES 2020 (advanced module), computer science / electrical engineering, Arbitrary semester
- Master Computer Science 2019 (optional subject), Canonical Specialization Data Science and AI, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master Computer Science 2019 (optional subject), advanced module, Arbitrary semester
- Master Biophysics 2019 (advanced module), advanced curriculum, 1st and 2nd semester
- Master IT-Security 2019 (advanced module), Elective Computer Science, 1st or 2nd semester
- Master MES 2014 (advanced module), computer science / electrical engineering, 1st and 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (advanced module), specific, 2nd and 3rd semester
- Master Computer Science 2014 (advanced module), advanced curriculum, 2nd and 3rd semester

Classes and lectures:

- CS4405 T: Neuro Informatics (lecture with exercises, 3 SWS)
- CS5450 T: Machine Learning (lecture with exercises, 3 SWS)
- CS5430 T: Seminar Machine Learning (seminar, 2 SWS)

Workload:

- 180 Hours private studies
- 120 Hours in-classroom work
- 40 Hours exam preparation
- 20 Hours work on an individual topic with written and oral presentation

Contents of teaching:

- see module parts

Qualification-goals/Competencies:

- see module parts

Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr. rer. nat. Thomas Martinetz

Teacher:

- Institute for Neuro- and Bioinformatics

- Prof. Dr. rer. nat. Thomas Martinetz
- Prof. Dr.-Ing. Erhardt Barth

Literature:

- : see module parts

Language:

- German and English skills required

Notes:

Admission requirements for taking the module:
- None

Admission requirements for participation in module examination(s):
- Successful completion of exercises and project tasks as specified at the beginning of the semester.
- Seminar lecture and elaboration according to the requirements at the beginning of the semester.

Module Exam(s):
- CS4511-L1: Learning Systems, oral exam, 100% of module grade.

(Consists of CS4405 T, CS5450 T, CS5430 T)

Only for computer science students with the application subject Bioinformatics, the course CS4405 T Neuroinformatics is replaced by CS5204 T Artificial Intelligence 2, because this group of participants must already complete Neuroinformatics as part of a required module.

CS4512-KP12, CS4512 - Imaging Systems and Inverse Problems (BildgebSys)

Duration:	Turnus of offer:	Credit points:
2 Semester	irregularly	12

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master Medical Informatics 2014 (optional subject), medical image processing, 1st and 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (advanced module), specific, 2nd and/or 3rd semester
- Master Computer Science 2014 (advanced module), advanced curriculum, 2nd and/or 3rd semester

Classes and lectures:

- Computed Tomography (lecture, 2 SWS)
- Magnetic Resonance Imaging (lecture, 2 SWS)
- Nuclear Imaging (lecture, 2 SWS)
- Inverse Problems in Imaging (lecture, 2 SWS)

Workload:

- 220 Hours private studies
- 120 Hours in-classroom work
- 20 Hours exam preparation

Contents of teaching:

- see module parts

Qualification-goals/Competencies:

- see module parts

Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr. rer. nat. Thorsten Buzug

Teacher:

- Institute of Medical Engineering

- Prof. Dr. rer. nat. Thorsten Buzug
- Prof. Dr. rer. nat. Martin Koch

Literature:

- :

Language:

- German and English skills required

Notes:

Prerequisites for attending the module:
- None

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

CS4515-KP12 - Computer and System Security (ComSysSec)

Duration:	Turnus of offer:	Credit points:
2 Semester	each year, can be started in winter or summer semester	12

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (advanced module), specific, 2nd and 3rd semester
- Master Computer Science 2019 (optional subject), advanced module, Arbitrary semester

Classes and lectures:

- Communication and System Security (lecture, 2 SWS)
- Communication and System Security (exercise, 1 SWS)
- Communication and System Security (seminar, 1 SWS)
- Computer Security (lecture, 2 SWS)
- Computer Security (practical course, 3 SWS)

Workload:

- 170 Hours private studies
- 150 Hours in-classroom work
- 40 Hours exam preparation

Contents of teaching:

- Applied cryptography in systems and protocols: Overview of common methods and their applications
- Efficient and secure implementation of common crypto procedures: multiple-precision arithmetic, efficient exponentiation, constant time algorithms etc.
- Physical implementation attacks and countermeasures: Error injection attacks, passive physical attacks such as SPA/DPA and timing attacks, modern inference methods and associated cryptanalysis methods, classes of protective measures
- Virtualization security and microarchitecture attacks: security concepts in the operating system and hypervisor, microarchitecture attacks such as cache attacks, spectre, etc., measures to restore system security
- Trusted Computing and Hardware-Assisted System Security: Functionality TPMs, Secure Elements and Trusted Execution Environments, basics and cryptographic techniques, design basics for secure systems
- Cryptographic procedures and protocols, security analyses
- IT security at system level, security mechanisms
- Security, privacy and trust of special systems like Cloud and IoT
- Operating system security
- Security management, legal framework conditions
- Security problems in IT systems

Qualification-goals/Competencies:

- The students can demonstrate a deep understanding of cryptographic methods and their applications in communication systems.
- They can construct secure and efficient cryptographic primitives and implement them securely in computer systems.
- They can explain methods and algorithms for efficient multiple-precision arithmetic.
- They can perform basic side-channel attacks on systems with physical access or shared systems with code execution rights.
- They can implement protection against specific physical attacks for cryptographic primitives.
- They can evaluate the security of existing primitives.
- Students can explain the basic methods in the field of cybersecurity and apply them to case studies.
- They can demonstrate a deeper understanding of cryptographic methods and their applications in communication systems.
- They can analyze the entire spectrum of the security of a system.
- They can explain modelling techniques and describe experiences with their use.
- They can apply a variety of standard techniques to increase the security of a system.

Grading through:

- Written or oral exam as announced by the examiner
- written homework

Requires:

- Cybersecurity (CS2250-KP04)
- Cryptology (CS3420-KP04, CS3420)

Responsible for this module:

- Prof. Dr.-Ing. Thomas Eisenbarth

Teacher:

- Institute for IT Security
- Prof. Dr.-Ing. Thomas Eisenbarth

Literature:

- S. Mangard, E. Oswald & T. Popp: Power analysis attacks: Revealing the secrets of smart cards - Vol. 31, Springer Science & Business Media, 2008
- D. Stinson: Cryptography: Theory and Practice - 4th ed., CRC Press, 2018
- Stallings, Brown: Computer Security: Principles and Practice - 4th ed., Pearson, 2018
- Katz, Lindell: Introduction to Modern Cryptography - 2nd ed., CRC Press, 2014
- : Recent literature

Language:

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

Notes:

Prerequisites for attending the module:
- None

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

CS4520-KP12, CS4520 - Case study in professional product development (Fallstudie)

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

Course of study, specific field and term:

- Master Artificial Intelligence 2023 (optional subject), for equivalence check, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master Computer Science 2019 (optional subject), advanced module, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (advanced module), specific, 2nd and 3rd semester
- Master Computer Science 2014 (advanced module), advanced curriculum, 2nd and 3rd semester

Classes and lectures:

- Basics for product development (exercise, 2 SWS)
- Product development (practical course, 6 SWS)

Workload:

- 120 Hours in-classroom work
- 120 Hours group work
- 70 Hours private studies
- 30 Hours oral presentation (including preparation)
- 20 Hours exam preparation

Contents of teaching:

- generating ideas for product development
- developing a business plan
- planning and developing a prototype
- techniques for management and planning
- product cycles
- economic studies
- licences

Qualification-goals/Competencies:

- Students can start working in or leading a team for product development in informatics.
- They can organize and conduct the different phases of product development.
- They can assess legal and economic restrictions of product development.
- They are able to play different roles in a developing team.

Grading through:

- Oral examination

Responsible for this module:

- Studiengangsleitung Informatik

Teacher:

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

Language:

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

Notes:

Basics for product development can be taught by various appropriate forms of instruction other than exercises.

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- continuous, successful participation in course
- presentation
- successful addressing of the project goals
- documentation
- grading by the reviewer

CS4555-KP04 - Media Transmission (MediaTrans)

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

Course of study, specific field and term:

- Master Entrepreneurship in Digital Technologies 2014 (optional subject), specific, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (optional subject), specific, Arbitrary semester
- Master Media Informatics 2020 (optional subject), media informatics, Arbitrary semester
- Master Media Informatics 2014 (compulsory), media informatics, 2nd semester

Classes and lectures:

- A/V Media on the Internet (lecture, 2 SWS)
- Implementation Streaming Services (exercise, 1 SWS)

Workload:

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

Contents of teaching:

- Audio and video compression
- Media transmission (broadcast / streaming)
- Communication protocols for multimedia
- Synchronization and adaptation
- Infrastructures (CDNs)
- Quality of Service (QoS)
- Applications (VoIP, IPTV, VoD)

Qualification-goals/Competencies:

- Students have a profound understanding of the complex challenges of transmitting audiovisual media in distributed systems.
- They are competent in applying appropriate means and techniques for A/V media on the Internet.
- They are able to estimate the effect of individual components, e.g. compressors and protocol, quantitatively and qualitatively.
- They can analyze, design, implement and evaluate media transmission systems.

Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr.-Ing. Andreas Schrader

Teacher:

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

Literature:

- Hans W. Barz, Gregory A. Bassett: Multimedia Networks. Protocols, Design and Applications - John Wiley & Sons, 1. Aufl., 2016

Language:

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

ME4250-KP12, ME4250 - Biophysics (BioPhys)

Duration:	Turnus of offer:	Credit points:
2 Semester	each winter semester	12

Course of study, specific field and term:

- Master MES 2020 (advanced module), mathematics / natural sciences, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (advanced module), specific, 2nd and 3rd semester
- Master MES 2014 (advanced module), mathematics / natural sciences, 1st and 2nd semester

Classes and lectures:

- See LS4020 C-MIW: Single molecule methods (course, 3 SWS)
- See LS4020 F-MIW: Protein-Biophysics (course, 3 SWS)
- See ME4260 T: Theoretical Biophysics (course, 3 SWS)
- See LS4130 A: Membrane Biophysics (course, 3 SWS)
- See ME4250 A: Instrumentation in Biophysics (course, 3 SWS)

Workload:

- 155 Hours private studies and exercises
- 145 Hours in-classroom work
- 60 Hours exam preparation

Contents of teaching:

- see description of the module parts

Qualification-goals/Competencies:

- see description of the module parts

Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr. rer. nat. Christian Hübner

Teacher:

- Institute of Physics

- Prof. Dr. rer. nat. Christian Hübner
- PD Dr. rer. nat. Hauke Paulsen

Literature:

- see literature of the module parts:

Language:

- offered only in German

Notes:

All module parts LS4020 C-MIW, LS4020 F-MIW, ME4260 T, LS4130 A, ME4250 A must be passed.

Prerequisites for attending the module:
- None

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

ME4410-KP12, ME4410 - Imaging Systems (BS)

Duration:	Turnus of offer:	Credit points:
2 Semester	each winter semester	12

Course of study, specific field and term:

- Master MES 2020 (compulsory), medical engineering science, 1st and 2nd semester
- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master Entrepreneurship in Digital Technologies 2014 (advanced module), specific, 1st and 2nd semester
- Master MES 2014 (compulsory), medical engineering science, 1st and 2nd semester

Classes and lectures:

- ME4411 T: Modul part: Computed Tomography (lecture, 2 SWS)
- ME4412 T: Modul part: Magnetic Resonance Imaging (lecture, 2 SWS)
- ME4413 T: Modul part: Nuclear Imaging (lecture, 2 SWS)
- Seminar Imaging Systems (seminar, 2 SWS)

Workload:

- 150 Hours private studies
- 125 Hours in-classroom work
- 45 Hours exam preparation
- 30 Hours written report
- 10 Hours oral presentation (including preparation)

Contents of teaching:

- as described for the module parts

Qualification-goals/Competencies:

- as described for the module parts

Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr. rer. nat. Thorsten Buzug

Teacher:

- Institute of Medical Engineering

- Prof. Dr. rer. nat. Thorsten Buzug
- Prof. Dr. rer. nat. Martin Koch
- Prof. Dr. rer. nat. Magdalena Rafecas

Literature:

- as described for the module parts:

Language:

- German and English skills required

Notes:

Prerequisites for attending the module:
- None

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

ME4420-KP12, ME4420 - Biomedical Optics (BMO)

Duration:	Turnus of offer:	Credit points:
2 Semester	each winter semester	12

Course of study, specific field and term:

- Master Biophysics 2023 (compulsory), biophysics, 1st and 2nd semester
- Master MES 2020 (compulsory), medical engineering science, 1st and 2nd semester
- Master Entrepreneurship in Digital Technologies 2020 (advanced module), specific, Arbitrary semester
- Master Biophysics 2019 (compulsory), biophysics, 1st and 2nd semester
- Master Entrepreneurship in Digital Technologies 2014 (advanced module), specific, 1st and 2nd semester
- Master MES 2014 (compulsory), medical engineering science, 1st and 2nd semester

Classes and lectures:

- ME4421 T: Module part: Biomedical Optics 1 (lecture, 2 SWS)
- ME4422 T: Module part: Biomedical Optics 2 (lecture, 2 SWS)
- ME4423 T: Module part: Laser physics and -technologies (lecture, 2 SWS)
- Seminar Biomedical Optics (seminar, 2 SWS)

Workload:

- 135 Hours private studies
- 120 Hours in-classroom work
- 55 Hours exam preparation
- 30 Hours oral presentation (including preparation)
- 20 Hours written report

Contents of teaching:

- as described for the module parts

Qualification-goals/Competencies:

- as described for the module parts

Grading through:

- Oral examination

Responsible for this module:

- Prof. Dr. rer. nat. Robert Huber

Teacher:

- Institute of Biomedical Optics

- Dr. rer. nat. Norbert Linz
- Prof. Dr. rer. nat. Gereon Hüttmann
- Prof. Dr. rer. nat. Robert Huber
- Dr. rer. nat. Ralf Brinkmann
- Prof. Dr. rer. nat. Sebastian Karpf

Literature:

- as listed for the module parts:

Language:

- German and English skills required

Notes:

Prerequisites for attending the module:
- None

Prerequisites for the exam:
- Examination requirement is the successful participation in one of the three module seminars (BMO1, BMO2, or Laser Physics). This includes mandatory attendance and a 20 minute scientific presentation followed by discussion.

Exam:
- A 30 minutes oral exam about the content of the lectures BMO1, BMO2 and laser physics.