Modulhandbuch

Computing Science - Dual-Subject Bachelor's Programme

im Sommersemester 2023

erstellt am 25/04/24

Basismodule

inf030 - Programming, Algorithms and Data Structures

Module label	Programming, Algorithms and Data Structures
Modulkürzel	inf030
Credit points	9.0 KP
Workload	270 h
Verwendbarkeit des Moduls	• Bachelor's Programme Business Informatics (Bachelor) > Basiscurriculum • Bachelor's Programme Computing Science (Bachelor) > Basismodule • Bachelor's Programme Economics and Business Administration (Bachelor) > Studienrichtung Wirtschaftsinformatik • Bachelor's Programme Mathematics (Bachelor) > Nebenfachmodule • Bachelor's Programme Sustainability Economics (Bachelor) > Wahlpflichtbereich • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Basismodule
Zuständige Personen	• Schönberg, Christian (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	No participant requirement
Skills to be acquired in this module	Programming is one of the basic activities of computer scientists and a prerequisite for many other courses in computer science studies. The aim of the module "Programming, Data Structures and Algorithms" is to learn the basic concepts of imperative, procedural and object-oriented programming using the Java programming language and to present known, efficient algorithms and data structures for various, frequently occurring problems. After completing the module, the students should be able to independently develop imperative and simple object-oriented programmes based on Java for solving smaller problems and assess the efficiency of their programmes. They should also be able to apply important algorithms and select them based on their complexity. **Professional competence** The students: • describe basic concepts of imperative programming with Java • recognise imperative programming terminology and use the appropriate terms accurately in discussions • recognise basic terminology of object-oriented programming • describe what programs presented to them do • independently develop programs to solve small problems • systematically examine their own and other people's programmes for errors • use modern programme development environments to develop and test programmes • create algorithms with general design concepts (e.g. Greedy method, divide-and-conquer method) • name algorithms and data structures for solving common problems and evaluate their applicability • name problems of efficiency of algorithmic solutions of concrete problems and evaluate them • make a well-founded choice of an algorithm and a data structure for solving a concrete problem • apply the learned algorithms and data structures sensibly to given and concrete problems **Methodological competence** The students: • solve given problems from the point of view of imperative or object-oriented programming • transfer practical experience in programme development to new tasks **Social competence** The students:

- communicate the structure and mode of operation of self-developed programmes to others
- present solutions to small tasks in front of groups

Self-competence
The students:

- organise themselves in finding algorithmic solutions to small and medium-sized problems in computer science
- incorporate the concepts of general programme design in their actions

Module contents

In the first part, general basic concepts of programming are introduced:

- Algorithm, programming languages, computer
- development tools, development phases
- compilers
- grammars
- logic

The second part deals with basic programming concepts:

- data types
- variables
- Expressions, statements
- control structures
- Methods, parameters
- recursion
- Reference data types, arrays
- Classes, objects
- Documentation
- Testing

The third part contains an introduction to data structures and algorithms as well as a discussion of their efficiency, i.e. the computational effort or memory requirements depending on the amount of data to be processed. The module introduces known, efficient algorithms and data structures for various, frequently occurring problems. These include in particular:

- Methods for searching for keys, as well as insertion and deletion indynamic data sets, e.g. lists, trees, AVL trees or hash methods,
- Methods for searching for text patterns,
- Methods for sorting data by key values, e.g. QuickSort and HeapSort,
- Graph-based applications, e.g. for finding shortest paths in graphs.
- The lecture part is supplemented by a comprehensive exercise part, in which in particular the taught programming contents are implemented in practical examples.

Literaturempfehlungen

Essential:

- Lecture Notes (made available either in printed form or via Stud.IP during the course of the lecture)

Good secondary literature:

- Dietmar Ratz, Jens Scheffler, Detlev Seese, Jan Wiesenberger: Grundkurs Programmieren in Java, Carl Hanser Verlag.
- Joachim Goll, Cornelia Heinisch: Java als erste Programmiersprache, Springer Vieweg Verlag
- Ottmann, Widmayer: Algorithmen und Datenstrukturen. Spektrum Verlag, 5. Auflage, 2012
- Segdewick, Wayne: Algorithms. Addison Wesley, 4th ed., 2011
- Siege: Einführung in die Informatik. Shaker Verlag, 2013

Links

Language of instruction		German		
Duration (semesters)		1 Semester		
Module frequency		every winter term		
Module capacity		unlimited		
Teaching/Learning method		1V + 1Ü		
Previous knowledge		none		
Examination	Prüfungszeiten		Type of examination	
Final exam of module	At the End of the Semester		Portfolio or written exam or oral exam	
Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		4	WiSe	56
Exercises		2	WiSe	28
Präsenzzeit Modul insgesamt				84 h

inf031 - Object-oriented Modelling and Programming

Module label	Object-oriented Modelling and Programming
Modulkürzel	inf031
Credit points	9.0 KP
Workload	270 h
Verwendbarkeit des Moduls	• Bachelor's Programme Business Informatics (Bachelor) > Basiscurriculum • Bachelor's Programme Computing Science (Bachelor) > Basismodule • Bachelor's Programme Economics and Business Administration (Bachelor) > Studienrichtung Wirtschaftsinformatik • Bachelor's Programme Mathematics (Bachelor) > Nebenfachmodule • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Basismodule
Zuständige Personen	• Schönberg, Christian (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	useful previous knowledge: inf030 Programming, Algorithms and Data Structures
Skills to be acquired in this module	Object orientation represents the state of the art in software development today. Given problems are first transformed into an object-oriented model and then into an object-oriented program with the help of object-oriented analysis and design methods. Aim of the module "Object-Oriented Modelling and Programming" is to learn basic concepts of object-oriented modelling using UML as the modelling notation and object-oriented programming using the Java programming language. After completing the module, students should be able to independently develop object-oriented programs based on Java for solving medium-sized problems. **Professional competence:** The students: • know basic concepts of object-oriented modelling and UML as modelling notation • know basic concepts of object-oriented programming with Java • know the terminology of object-oriented modelling and programming and use the appropriate terms precisely in discussions • can describe what object-oriented programmes presented to them do • independently develop models and programmes for solving medium-sized problems • systematically examine their own and other people's models and programmes for errors • use modern development environments for modelling and developing programmes • know the differences between the imperative, object-oriented, functional, logical and rule-based programming paradigms **Methodological competence**: The students: • independently develop programmes for given problems by consistently applying the concepts of object-oriented modelling and programming • transfer practical experience in programme development to new tasks • independently develop programmes with concurrency • can independently apply known solution methods to complex problems **Social competence:** The students: • communicate the structure and mode of action of self-developed models and programmes to others • present independently developed solutions to groups **Self-competence:** The students: • organise themselves when developing programmes for small and medium-sized problems in computer science • incorporate the concepts of object-oriented programme design in their actions

Module contents

In the first part, basic concepts of object-oriented modelling and programming are taught:

- Models and modelling
- UML class diagrams
- Classes and objects
- data encapsulation
- inheritance
- Polymorphism and dynamic binding
- Exception handling
- Genericity

In the second part, important concepts and classes of the JDK class library are introduced and the classes are used in solving medium-sized problems:

- Java Collection API
- IO and Streams
- GUI applications with JavaFX
- Parallel programming with threads

In the third part, advanced solution strategies are presented and other programming paradigms are introduced and compared with the object-oriented paradigm:

- Backtracking, Branch and Bound, Greedy
- Local Search, Evolutionary Algorithms
- Functional programming (e.g. Java-Lamdas, Standard ML)
- Logical programming (e.g. Prolog)
- Rule-based programming (e.g. Drools)

The lecture part is supplemented by a comprehensive exercise part, in which in particular the taught contents are implemented in practical examples.

Literaturempfehlungen

Essential:

- Lecture Notes (made available either in printed form or via Stud.IP during the course of the lecture)

Good secondary literature:

- Heide Balzert: Lehrbuch der Objektmodellierung: Analyse und Entwurf mit der UML 2, Spektrum Akademischer Verlag
- Dietmar Ratz, Jens Scheffler, Detlev Seese, Jan Wiesenberger: Grundkurs Programmieren in Java, Carl Hanser Verlag.
- Christian Ullenboom: Java ist auch eine Insel: Programmieren lernen mit dem Standardwerk für Java- Entwickler, Rheinwerk Computing
- Christian Ullenboom: Java SE 8 Standard-Bibliothek: Das Handbuch für Entwickler, Rheinwerk Computing

Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	every summer term
Module capacity	unlimited
Teaching/Learning method	1V + 1Ü
Previous knowledge	useful previous knowledge: inf030 Programming, Algorithms and Data Structures

Examination	Prüfungszeiten	Type of examination
Final exam of module	At the end of the Semester.	Portfolio or written exam or oral exam

Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		4	SoSe	56

Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Exercises		2	SoSe	28
Präsenzzeit Modul insgesamt				84 h

inf200 - Computer Engineering I

Module label	Computer Engineering I
Modulkürzel	inf200
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Computing Science (Bachelor) > Basismodule • Bachelor's Programme Mathematics (Bachelor) > Nebenfachmodule • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Basismodule • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Wahlpflicht Technische Informatik (30 KP) • Master of Education Programme (Vocational and Business Education) Computing Science (Master of Education) > Akzentsetzungsbereich
Zuständige Personen	• Rauh, Andreas (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	No participant requirements
Skills to be acquired in this module	he students learn to understand the construction of digital circuits and digital computers. They know the technological parameters, the state of the art technologies, and the developments characterizing current and future design paradigms for digital hardware. They learn to understand the concepts underlying current computer architectures and are able to explain how such architectures execute programs. Successful participants will be able to analyze computer architectures as a whole, to understand in depth, to analyze, and to optimize their hardware components, and to discuss the properties induced by selecting design alternatives. **Professional competences** The Students: • identify fundamental concepts of the construction of digital computer systems, the internal number representation, and analysis of combinational logic as well as their optimization. **Methological competences** The Students: • analyze computer architectures on the basis of their individual components • design and optimize digital hardware components • transfer systematic approaches of hardware design to unknown design problems **Social competences** The Students: • present their understanding of the functional principles of digital computer systems **Self-competences** The Students: • critically reflect on the results of exercises and recognize limitations of different approaches to the design of digital computer systems
Module contents	This module is the first part of the introduction to computer engineering. It explains the construction principles of computers, from the implementation of an easy Instruction Set Architecture, over fundamental techniques for coding and representation of numbers, program execution on machine level, basics of logics and analysis of functions of combinational logic as well as their optimization.
Literaturempfehlungen	• Lecture Notes • Schiffmann, W.; Schmitz, R. (2001): Technische Informatik I, II, Übungsbuch; Springer Verlag, Berlin. • Dal Cin, M. (1996): Rechnerarchitektur; B.G. Teubner. • Lagemann, K. (1987): Rechnerstrukturen; Springer-Verlag, Berlin. • Oberschelp, W.; Vossen, G. (1989): Rechneraufbau und Rechnerstrukturen; Oldenbourg-Verlag.

- Mano, Morris M.(1993): Computer System Architecture 3; Prentice Hall.
- Gajski, D.(1997): Principles of Digital Design; Prentice Hall.
- Patterson, D.A.; Hennessy, J.L. (1997): Computer Organization and Design:
- The Hardware/Software Interface; 2. Edition; Morgan Kaufmann Publishers.
- Wilkinson, B. (1996): Computer Architecture Design and Performance; 2. Edition; Prentice Hall.
- Tanenbaum, A.S.(1999): Structured Computer Organization; 4. Edition; Prentice Hall.

Links				
Language of instruction		German		
Duration (semesters)		1 Semester		
Module frequency		annual		
Module capacity		unlimited		
Teaching/Learning method		1VL + 1Ü		
Previous knowledge		none		
Examination	Prüfungszeiten		Type of examination	
Final exam of module	At the end of the lecture term		Written or oral exam	
Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	WiSe	42
Exercises		1	WiSe	14
Präsenzzeit Modul insgesamt				56 h

inf700 - Computer Science Education I

Module label	Computer Science Education I
Modulkürzel	inf700
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Business Informatics (Bachelor) > Wahlbereich Informatik, Kultur und Gesellschaft • Bachelor's Programme Computing Science (Bachelor) > Akzentsetzungsbereich - Wahlbereich Informatik • Bachelor's Programme Computing Science (Bachelor) > Wahlbereich Informatik, Kultur und Gesellschaft • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Aufbaumodule (60 KP) • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Basismodule
Zuständige Personen	• Diethelm, Ira (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	Basic knowledge of computer science
Skills to be acquired in this module	Professional competence The students: • characterise the different computer science education (CSE) concepts and approaches, e.g. the early approaches of CSE in school or the concept of computer science (CS) in contexts • select and discuss teaching subjects by analysing didactic approaches and concepts • describe the general education character of CS • compare the different approaches and concepts of CSE and are able to illustrate common features and contradictions • reflect lesson subjects by the approaches and topics of CSE **Methodological competence** The students: • link the concepts and approaches of CSE with the educational reconstruction • classify the similarities and differences of the concepts and approaches of CSE academically **Social competence** The students: • discuss the concepts and approaches of CSE with students and lectures academically • accept the thoughts of other students and lectures • give and accept criticism objectively **Self-competence** The students: • integrate the concepts and approaches of CSE into their planning and operations - reflect their self-perception with regard to the concepts and approaches of CSE
Module contents	The field of CSE is introduced by this module. Different CSE approaches and concepts are presented. **These CSE approaches and concepts are, e.g.:** • early concepts of CS in schools • general education character of CS • idea oriented approach of CSE • information centred approach of CSE • CSE in elementary school

- system oriented approach Subjects like „CS projects in class“ are also part of this module.

Literaturempfehlungen

- Schwill, A.; Schubert, S.: Didaktik der Informatik. Berlin: Spektrum Akademischer Verlag, 2004.
- Hubwieser, P.: Didaktik der Informatik. Berlin: Springer Verlag, 2000.

Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	annual
Module capacity	unlimited
Teaching/Learning method	V+Ü
Previous knowledge	Basic knowledge of computer science

Examination	Prüfungszeiten	Type of examination
Final exam of module		
	At the end of the lecture period	Oral exam

Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		2	SoSe	28
Exercises		2	SoSe	28
Präsenzzeit Modul insgesamt				56 h

mat950 - Discrete Mathematics

Module label	Discrete Mathematics
Modulkürzel	mat950
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Business Informatics (Bachelor) > Aufbaucurriculum - Pflichtbereich • Bachelor's Programme Computing Science (Bachelor) > Aufbaumodule • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Basismodule
Zuständige Personen	• Heß, Florian (module responsibility) • Stein, Andreas (module responsibility) • Stein, Sandra (module responsibility)
Prerequisites	
Skills to be acquired in this module	• Getting to know and to understand the axiomatic structure of mathematics and the importance of mathematical reasoning • Mastering basic mathematical proof techniques and their logical structure • Recognizing the relevance of premises in mathematical theorems: Localization of premises within proofs and possible consequences if premises are not met • Exemplary acquaintance with further mathematical areas and thus expansion of the student's mathematical knowledge • Getting to know applications • Integration and crosslinking of the student's mathematical knowledge by establishing relationships between different mathematical areas • Learning the essential ideas and methods for discrete structures in mathematics • Knowledge of the fundamental concepts and methods of graph theory • Knowledge of the fundamental concepts and methods of algebra and number theory, such as groups, rings, fields, residue class rings, Euclidean algorithm, Chinese remainder theorem, polynomials. • Knowledge of further concepts and methods for discrete structures, e.g. primality tests, RSA, graph-theoretical algorithms
Module contents	Elements of propositional logic, proof techniques, sets, relations and maps, combinatorics, graphs and applications, the ring of integers and residue class rings, groups and semi groups
Literaturempfehlungen	Kreußler, Pfister: Mathematik für Informatiker, Springer 2009. Knauer, Knauer: Diskrete und algebraische Strukturen - kurz gefasst, Springer 2015. Aigner: Diskrete Mathematik, Vieweg 2006. Beutelspacher, Zschiegner: Diskrete Mathematik für Einsteiger, Vieweg 2014. Epp: Discrete Mathematics with Applications, Brooks Cole 2011. Graham, Knuth, Patashnik: Concrete Mathematics, Addison-Wesley 1994. Hartmann: Mathematik für Informatiker, Vieweg 2014. Rosen: Discrete Mathematics and its applications, McGraw-Hill 2018. Steger: Diskrete Strukturen, Band 1, Springer 2007. Teschl, Teschl: Mathematik für Informatiker, Band 1, Springer 2013. Further reading will be announced in the lecture.
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	annual
Module capacity	unlimited
Reference text	Im Zwei-Fächer Bachelor Informatik ist dieses Modul im Basiscurriculum zu studieren.

Examination	Prüfungszeiten	Type of examination
Final exam of module	after the end of the lecture period	Written exam or oral exam. Bonus points can be earned.

Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	WiSe	42
Exercises		1	WiSe	14

Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Präsenzzeit Modul insgesamt				56 h

Aufbaumodule (60 KP)

inf005 - Software Engineering I

Module label	Software Engineering I
Modulkürzel	inf005
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Business Informatics (Bachelor) > Aufbaucurriculum - Pflichtbereich • Bachelor's Programme Computing Science (Bachelor) > Aufbaumodule • Bachelor's Programme Mathematics (Bachelor) > Nebenfachmodule • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Aufbaumodule (60 KP) • Master of Education Programme (Vocational and Business Education) Computing Science (Master of Education) > Pflichtbereich • Master's Programme Environmental Modelling (Master) > Mastermodule
Zuständige Personen	• Winter, Andreas (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	• inf030 • inf031
Skills to be acquired in this module	The objective of the module is to convey the development and maintainance of large scale software systems. The complete software developing process including requirements collection, software architecture and quality control is observed. The basics of object oriented modelling and software development are enhanced. **Professional competence** The students: • comprehend the different developmental phases of software (especially requirements engineering, software design, software implementation and quality control) • name the tasks of each phase • select appropriate methodical utilities • select suitable methods and utilities for each project phase • understand the advantages of the modelling process with UML • model moderate tasks in UML • understand and develop solutions for given problems by means of development environments **Methodological competence** The students: • structure, document and evaluate problems and solutions with the tools of object oriented modelling • apply methods and techniques of object oriented modelling purposefully **Social competence** The students: • create, present and discuss solutions with modelling techniques - • present and solve modelling problems in teams **Self-competence** The students: reflect their problem-solving behaviour with regard to the capabilities of software technology
Module contents	The module introduces fundamental terms and concepts in software engineering. This includes: • need for software engineering • activities and process-models in software development • object-oriented modelling, meta modelling • Interdependencies between code and models • requirements elicitation

- definition of software architectures
- application of software patterns
- software quality management
- software maintenance, evolution and operation Software engineering tools are presented and applied in practical exercises.

Literaturempfehlungen

- Slide script for the lecture
- Ian Sommerville: Software Engineering, Addison-Wesley Longman, Amsterdam, 10. Ed. 2012
- Jochen Ludewig, Horst Lichter: Software Engineering, dpunkt.verlag, 3. Auflage 2013
- Helmut Balzert: Lehrbuch der Software-Technik, Spektrum Akademischer Verlag, 3. Auflage 2009
- Chris Rupp, Stefan Queins: UML 2 glasklar. Praxiswissen für die UML-Modellierung, Carl Hanser Verlag, 4. Auflage 2012

Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	annual
Module capacity	unlimited
Teaching/Learning method	V+Ü
Previous knowledge	- inf030 - inf031

Examination	Prüfungszeiten	Type of examination
Final exam of module	At the end of the lecture period or during the lecture period (portfolio)	Written exam or oral exam or portfolio (? 3 services)

Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	WiSe	42
Exercises		2	WiSe	28
Präsenzzeit Modul insgesamt				70 h

inf007 - Information Systems I

Module label	Information Systems I
Modulkürzel	inf007
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Business Informatics (Bachelor) > Aufbaucurriculum - Pflichtbereich • Bachelor's Programme Computing Science (Bachelor) > Aufbaumodule • Bachelor's Programme Economics and Business Administration (Bachelor) > Studienrichtung Wirtschaftsinformatik • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Aufbaumodule (60 KP) • Master Applied Economics and Data Science (Master) > Specialization • Master of Education Programme (Vocational and Business Education) Computing Science (Master of Education) > Pflichtbereich
Zuständige Personen	• Wingerath, Wolfram (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	No participant requirement
Skills to be acquired in this module	This module introduces the core concepts, languages and architectures of databases. In software systems these concepts are important. **Professional competence** The students: • name the core concepts of the languages and architectures of databases (especially) • select data models • integrate structuring concepts of information systems in their designs **Methodological competence** The students: • design database systems appropriatelyanalyse problems from the field of database-supported • information systems and solve them appropriately **Social competence** The students: • enhance their ability to work in a team **Self-competence** The students: • reflect their problem-solving behaviour with regard to the information processing concepts
Module contents	• Relational data models • Relational algebra and its implementation in SQL (the standard of databases) • Database design on different abstractions (conceptual and logical design) • Normalisation - Data base architectures • Distributed and active databases • Object-oriented, object-related and XML-based database systems
Literaturempfehlungen	• Ramez Elmasri und Shamkant B. Navathe (2016), Fundamentals of Databases Systems, 7th Revised edition, Pearson/Addison Wesley.
Links	
Language of instruction	German

Duration (semesters)		1 Semester		
Module frequency		annual		
Module capacity		unlimited		
Teaching/Learning method		V+Ü		
Previous knowledge		none		
Examination		Prüfungszeiten	Type of examination	
Final exam of module		At the end of the lecture period	Written or oral exam	
Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	WiSe	42
Exercises		1	WiSe	14
Präsenzzeit Modul insgesamt				56 h

inf700 - Computer Science Education I

Module label	Computer Science Education I
Modulkürzel	inf700
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Business Informatics (Bachelor) > Wahlbereich Informatik, Kultur und Gesellschaft • Bachelor's Programme Computing Science (Bachelor) > Akzentsetzungsbereich - Wahlbereich Informatik • Bachelor's Programme Computing Science (Bachelor) > Wahlbereich Informatik, Kultur und Gesellschaft • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Aufbaumodule (60 KP) • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Basismodule
Zuständige Personen	• Diethelm, Ira (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	Basic knowledge of computer science
Skills to be acquired in this module	Professional competence The students: • characterise the different computer science education (CSE) concepts and approaches, e.g. the early approaches of CSE in school or the concept of computer science (CS) in contexts • select and discuss teaching subjects by analysing didactic approaches and concepts • describe the general education character of CS • compare the different approaches and concepts of CSE and are able to illustrate common features and contradictions • reflect lesson subjects by the approaches and topics of CSE **Methodological competence** The students: • link the concepts and approaches of CSE with the educational reconstruction • classify the similarities and differences of the concepts and approaches of CSE academically **Social competence** The students: • discuss the concepts and approaches of CSE with students and lectures academically • accept the thoughts of other students and lectures • give and accept criticism objectively **Self-competence** The students: • integrate the concepts and approaches of CSE into their planning and operations - reflect their self-perception with regard to the concepts and approaches of CSE
Module contents	The field of CSE is introduced by this module. Different CSE approaches and concepts are presented. **These CSE approaches and concepts are, e.g.:** • early concepts of CS in schools • general education character of CS • idea oriented approach of CSE • information centred approach of CSE • CSE in elementary school

- system oriented approach Subjects like „CS projects in class“ are also part of this module.

Literaturempfehlungen

- Schwill, A.; Schubert, S.: Didaktik der Informatik. Berlin: Spektrum Akademischer Verlag, 2004.
- Hubwieser, P.: Didaktik der Informatik. Berlin: Springer Verlag, 2000.

Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	annual
Module capacity	unlimited
Teaching/Learning method	V+Ü
Previous knowledge	Basic knowledge of computer science

Examination	Prüfungszeiten	Type of examination
Final exam of module		
	At the end of the lecture period	Oral exam

Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		2	SoSe	28
Exercises		2	SoSe	28
Präsenzzeit Modul insgesamt				56 h

Praktische Vertiefung (60 KP)

inf004 - Software Project

Module label	Software Project
Modulkürzel	inf004
Credit points	9.0 KP
Workload	270 h
Verwendbarkeit des Moduls	

- Bachelor's Programme Biology (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Bachelor's Programme Business Administration and Law (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Bachelor's Programme Business Informatics (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Bachelor's Programme Chemistry (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Bachelor's Programme Comparative and European Law (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel more...
- Bachelor's Programme Computing Science (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Bachelor's Programme Economics and Business Administration (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Bachelor's Programme Education (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Bachelor's Programme Engineering Physics (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Bachelor's Programme Environmental Science (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Bachelor's Programme Intercultural Education and Counselling (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Bachelor's Programme Mathematics (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Bachelor's Programme Physics (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Bachelor's Programme Physics, Engineering and Medicine (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Bachelor's Programme Social Studies (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Bachelor's Programme Sustainability Economics (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Dual-Subject Bachelor's Programme Art and Media (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Dual-Subject Bachelor's Programme Biology (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Dual-Subject Bachelor's Programme Chemistry (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Praktische Vertiefung (60 KP)
- Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Dual-Subject Bachelor's Programme Dutch Linguistics and Literary Studies (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Dual-Subject Bachelor's Programme Economic Education (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Dual-Subject Bachelor's Programme Economics and Business Administration (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Dual-Subject Bachelor's Programme Education (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Dual-Subject Bachelor's Programme Elementary Mathematics (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Dual-Subject Bachelor's Programme English Studies (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Dual-Subject Bachelor's Programme Gender Studies (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
- Dual-Subject Bachelor's Programme General Education (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel

	• Dual-Subject Bachelor's Programme German Studies (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel • Dual-Subject Bachelor's Programme History (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel • Dual-subject bachelor's programme Low German (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel • Dual-Subject Bachelor's Programme Material Culture: Textiles (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel • Dual-Subject Bachelor's Programme Mathematics (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel • Dual-Subject Bachelor's Programme Music (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel • Dual-Subject Bachelor's Programme Philosophy / Values and Norms (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel • Dual-Subject Bachelor's Programme Physics (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel • Dual-Subject Bachelor's Programme Politics-Economics (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel • Dual-Subject Bachelor's Programme Protestant Theology and Religious Education (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel • Dual-Subject Bachelor's Programme Slavic Studies (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel • Dual-Subject Bachelor's Programme Social Studies (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel • Dual-Subject Bachelor's Programme Special Needs Education (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel • Dual-Subject Bachelor's Programme Sport Science (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel • Dual-Subject Bachelor's Programme Technology (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel • Fach-Bachelor Pädagogisches Handeln in der Migrationsgesellschaft (Bachelor) > Praxismodule für Studierende mit außerschulischem Berufsziel
Zuständige Personen	• Grawunder, Marco (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	Java Programming Course, Software Engineering , Algorithms and Data Structures
Skills to be acquired in this module	The students will be able to develop software iteratively in a team. This includes all stages of the software life cycle (requirements, analysis, design, implementation, test) and the presentation of the software development process. The students improve their Java skills. Professional competence The students: - Apply software development techniques and methods and are aware of the techniques' limitations **Professional competence:** The students: • apply techniques and methods and recognize their limitations **Methodological competence** The students: • develop complex software with software engineering methods using a process-model and document these appropriately • make a rough schedule/estimate on tasks • implement an iterative process • familiarise themselves with unknown systems and frameworks • process complex tasks based on science and engineering and split them in subtasks • organise and implement small-scale projects • present and document the outcome of the project **Social competence** The students: • work in a team and solve conflicts • develop complex software in a team and assess the required efforts (time management) • reflect their self-performance and the performance of other students (review and retrospective) **Self-competence** The students:

- improve their capacity for teamwork, in particular the ability to solve conflicts

Module contents	In a two-semester course a team of students develops a larger system. For this project a Scrum similar model is used. Typical external stakeholders/roles are represented by members of the team. Feedback is provided in regular presentations (two per semester with the lecturer, weekly in the seminars). An accompanying lecture block provides the most important software engineering subjects and repeats or deepens new methods and techniques necessary for the project.
Literaturempfehlungen	
Links	https://confluence.swp.offis.uni-oldenburg.de/display/SWPWP
Language of instruction	German
Duration (semesters)	2 Semester
Module frequency	annual
Module capacity	unlimited
Teaching/Learning method	1VL + 1Ü + 1PR
Previous knowledge	Java Programming Course, Software Engineering , Algorithms and Data Structures

Examination	Prüfungszeiten	Type of examination
Final exam of module	by appointment	Portfolio

Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		2	WiSe	28
Exercises		2	SoSe und WiSe	28
Project		4	SoSe und WiSe	56
Präsenzzeit Modul insgesamt				112 h

inf009 - Database Practical

Module label	Database Practical
Modulkürzel	inf009
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Business Informatics (Bachelor) > Akzentsetzungsbereich Praktische Informatik und Angewandte Informatik • Bachelor's Programme Computing Science (Bachelor) > Akzentsetzungsbereich - Wahlbereich Informatik • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Praktische Vertiefung (60 KP) • Master of Education Programme (Gymnasium) Computing Science (Master of Education) > Wahlpflichtmodule (Praktische Informatik) • Master of Education Programme (Hauptschule and Realschule) Computing Science (Master of Education) > Mastermodule • Master of Education Programme (Vocational and Business Education) Computing Science (Master of Education) > Praktische Vertiefung der Informatik
Zuständige Personen	• Grawunder, Marco (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	• Information Systems I • Operating system knowledge
Skills to be acquired in this module	The objective of this module is to gather practical experience on databases and information systems. The students get an overview of the technical realisation, implementation and optimisation of a professional database management system. **Professional competence** The students: • Realise, implement and program data base systems • Program and implement database-oriented system routines • Implement optimisation goals in the modelling phase • Administer professional database systems (installation, maintenance and adjustment) • Recognise database systems' performance problems and are able to fix them with according methods • Organise and control processes of database systems **Methodological competence** The students: • propose concrete processing principles for special application classes • reflect on specific technologies and procedures with regard to their consequences **Social competence** The students: • Solve database system problems in a team **Self-competence** The students: • Acknowledge the limits of their ability to cope with pressure during the implementation and are aware of failures • Reflect their self-perception
Module contents	The module “Practical Course Databases” is a related practical course of the module “Information Systems I”. The objectives of this module are special technical concepts of a database system and practical solutions in database programming and optimisation. **Contents of this module are:** • System-oriented database management programming, • Implementation of catalogue systems,

- Optimisation strategies based on parallelisation and partitioning requirements

Literaturempfehlungen

- Ramez Elmasri und Shamkant B. Navathe (2007). Fundamentals of Databases Systems. Fifth Edition, Pearson/Addison Wesley
- Held Andrea (2005), Oracle 10g Hochverfügbarkeit Addison-Wesley -
- Held Andrea (2015), Oracle 12c New Features Addison Wesley
- Feuerstein Steven, Pribyl Bill, Dawes Chip (2007).Oracle PL/SQL. 4. Auflage, O'Reillys Taschenbibliothek

Links	http://www-is.informatik.uni-oldenburg.de/227/
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	every winter term
Module capacity	unlimited
Teaching/Learning method	P
Previous knowledge	Information Systems I Operating system knowledge

Examination	Prüfungszeiten	Type of examination
Final exam of module	At the end of the lecture period	Oral exam

Lehrveranstaltungsform	Exercises
SWS	4
Frequency	WiSe
Workload Präsenzzeit	56 h

inf014 - Operating Systems Practical

Module label	Operating Systems Practical
Modulkürzel	inf014
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Computing Science (Bachelor) > Akzentsetzungsbereich - Wahlbereich Informatik • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Praktische Vertiefung (60 KP) • Master of Education Programme (Vocational and Business Education) Computing Science (Master of Education) > Praktische Vertiefung der Informatik
Zuständige Personen	• Theel, Oliver (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	• Information Systems I • Operating Systems I- Operating Systems II • Programming languages: C, Assembler
Skills to be acquired in this module	The aim of this module is to get practical experience in the field of analysis, design, and implementation methods of components of operating systems and their interactions. **Professional competence** The students: • familiarise with complex software systems • implement hardware-related components of operating systems • describe parallel system operation executions • understand the basic concepts of the programming language C++ • lientify software errors systematically, especially regarding parallel software • work in teams • use UNIX standard software to solve problems • recognise the advantage of working with virtual machines **Methodological competence** The students: • are aware of the challenges in handling operating systems • transfer operating system concepts to a practical context • analyse different solutions to a problem wrt. their properties • select the most suitable solution **Social competence** The students: • solve problems in small teams • present their solutions to all teams • discuss their different solutions within their own team and among all teams **Self-competence** The students: • accept criticism • organise the workflows within their teams • question their potential solutions in the light of criticism received • identify own shortcomings in their initial ability to successfully transfer theory to praxis
Module contents	The contents of this module are: • Analysis of a rudimentary operating system • Design and implementation of a process management subsystem • Design and implementation of process synchronisation mechanisms • Design and implementation of a virtual memory management subsystem • Design and implementation of a file subsystem or dialog subsystem

Literaturempfehlungen	• Patterson and Hennessy, Computer Organization and Design, 3rd edition, Morgan Kaufmann, 2007
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	every winter term
Module capacity	unlimited
Reference text	**Associated with the modules:** • Operating Systems I • Operating Systems II • Distributed Systems
Teaching/Learning method	P
Previous knowledge	- Operating Systems I - Operating Systems II - Programming languages: C, Assembler

Examination	Prüfungszeiten	Type of examination
Final exam of module	At the end of the semester	Active participation / work report and oral exam

Lehrveranstaltungsform	Practical training
SWS	4
Frequency	WiSe
Workload Präsenzzeit	56 h

inf018 - Media Processing

Module label	Media Processing
Modulkürzel	inf018
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	

- Bachelor's Programme Biology (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Bachelor's Programme Business Administration and Law (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Bachelor's Programme Business Informatics (Bachelor) > Akzentsetzungsbereich Praktische Informatik und Angewandte Informatik
- Bachelor's Programme Business Informatics (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Bachelor's Programme Chemistry (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer" more...
- Bachelor's Programme Comparative and European Law (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Bachelor's Programme Computing Science (Bachelor) > Akzentsetzungsbereich - Wahlbereich Informatik
- Bachelor's Programme Computing Science (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Bachelor's Programme Economics and Business Administration (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Bachelor's Programme Education (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Bachelor's Programme Engineering Physics (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Bachelor's Programme Environmental Science (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Bachelor's Programme Intercultural Education and Counselling (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Bachelor's Programme Mathematics (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Bachelor's Programme Physics (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Bachelor's Programme Physics, Engineering and Medicine (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Bachelor's Programme Social Studies (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Bachelor's Programme Sustainability Economics (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Dual-Subject Bachelor's Programme Art and Media (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Dual-Subject Bachelor's Programme Biology (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Dual-Subject Bachelor's Programme Chemistry (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Dual-Subject Bachelor's Programme Computing Science (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Praktische Vertiefung (60 KP)
- Dual-Subject Bachelor's Programme Dutch Linguistics and Literary Studies (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Dual-Subject Bachelor's Programme Economic Education (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Dual-Subject Bachelor's Programme Economics and Business Administration (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Dual-Subject Bachelor's Programme Education (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Dual-Subject Bachelor's Programme Elementary Mathematics (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"
- Dual-Subject Bachelor's Programme English Studies (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer"

	• Dual-Subject Bachelor's Programme Gender Studies (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer" • Dual-Subject Bachelor's Programme General Education (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer" • Dual-Subject Bachelor's Programme German Studies (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer" • Dual-Subject Bachelor's Programme History (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer" • Dual-subject bachelor's programme Low German (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer" • Dual-Subject Bachelor's Programme Material Culture: Textiles (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer" • Dual-Subject Bachelor's Programme Mathematics (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer" • Dual-Subject Bachelor's Programme Music (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer" • Dual-Subject Bachelor's Programme Philosophy / Values and Norms (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer" • Dual-Subject Bachelor's Programme Physics (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer" • Dual-Subject Bachelor's Programme Politics-Economics (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer" • Dual-Subject Bachelor's Programme Protestant Theology and Religious Education (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer" • Dual-Subject Bachelor's Programme Slavic Studies (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer" • Dual-Subject Bachelor's Programme Social Studies (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer" • Dual-Subject Bachelor's Programme Special Needs Education (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer" • Dual-Subject Bachelor's Programme Sport Science (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer" • Dual-Subject Bachelor's Programme Technology (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer" • Fach-Bachelor Pädagogisches Handeln in der Migrationsgesellschaft (Bachelor) > PP "Medieninformatik für Studierende musisch-künstlerischer Fächer" • Master of Education Programme (Gymnasium) Computing Science (Master of Education) > Wahlpflichtmodule (Praktische Informatik) • Master of Education Programme (Vocational and Business Education) Computing Science (Master of Education) > Praktische Vertiefung der Informatik • Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
Zuständige Personen	• Boll-Westermann, Susanne (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	Solid programming skills in Java and/or C++, practical informatics. Interest in media processing
Skills to be acquired in this module	The students can explain the basics of image processing and know which algorithms exist for the basic tasks in image processing and how these are applied. The students can apply basic methods of image processing they learned in the lecture to solve simple problems. **Professional compentence:** The students • can name basic characteristics of digital media • can explain the most common methods for encoding and compressing images, video and audio • can describe basic procedures for image enhancement, feature extraction, feature description, image analysis and image comprehension **Methodological competence:** The students • can recognize and evaluate image properties and decide for suitable image processing methods • can select existing software packages for simple image processing problems, as well as use and customize them for their specific task • can implement simple image and media processing functions in a higher programming language (e.g., C ++)

Social competence
The students:

- can plan, implement, and document a software project in team work
- can present the results of their work to an audience and adequately respond to criticism and questions

Self competence
The students:

- can accept and learn from mistakes made during the process of implementation

Module contents	The lecture covers the technologies of media processing. In particular, the lecture focuses on image processing chain from digital imaging, through image pre-/and postprocessing, and image storage to image analysis. In addition to compression techniques and color space theory (RGB, HSV, YUV, CIEXYZ, ...), the topics of the lecture include image enhancement, feature extraction, feature description, image analysis and image comprehension. The lecture furthermore discusses the encoding and analysis of video and audio.
Literaturempfehlungen	• Wilhelm Burger und Mark James Burge. Digitale Bildverarbeitung: Eine Einführung mit Java und Image, J. Springer, 2006. • Literatur im Handapparat der Abteilung in der Bibliothek. • Linkliste im Lernmanagementsystem zu den einzelnen Themen der Vorlesung.
Links	https://uol.de/en/media-informatics/teaching/courses
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	every winter term
Module capacity	12
Reference text	
Teaching/Learning method	V+Ü
Previous knowledge	Solid programming skills in Java and/or C++, practical informatics. Interest in media processing

Examination	Prüfungszeiten	Type of examination
Final exam of module	The presentation of the practical project on a project day of all small groups takes place directly after the lecture period. The oral examination takes place in the first two weeks after the end of the lecture period. Any post-examinations will take place at the end of the lecture period. The exact schedule can be found on the department's web pages as well as the information in the learning management system Stud.IP.	Project and oral Exam or project and written exam

Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		2	WiSe	28
Exercises		2	WiSe	28
Präsenzzeit Modul insgesamt				56 h

inf021 - Advanced Java Technologies

Module label	Advanced Java Technologies
Modulkürzel	inf021
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Business Informatics (Bachelor) > Akzentsetzungsbereich Praktische Informatik und Angewandte Informatik • Bachelor's Programme Computing Science (Bachelor) > Akzentsetzungsbereich - Wahlbereich Informatik • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Praktische Vertiefung (60 KP) • Master of Education Programme (Vocational and Business Education) Computing Science (Master of Education) > Praktische Vertiefung der Informatik
Zuständige Personen	• Boles, Dietrich (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	useful knowledge: Object-oriented programming
Skills to be acquired in this module	The objective of this module is to introduce advanced concepts and technologies of the Java Standard Edition. The students will be able to use the technologies to implement large applications. **Professional competence:** The students: • name the essential packages of the JDK class library • structure large programs properly and implement them extensively • set up own Java class libraries • look up required classes in the JDK-Library and solve problems with these classes • structure their programs properly • understand and interpret large programs of other students • evaluate the quality of large programs related to their maintainability, reuseability and expandability **Methodological competence:** The students: • search for solutions to specific problems in the internet independently **Social competence:** The students: • discuss own and solutions of other students **Self-competence:** The students: • reflect their problem-solving behaviour and take up new solutions, e.g. from the internet
Module contents	A selection of the following subjects is presented during the lectures: • GUI (AWT, Swing, JavaFX) • Java-Basics and Collection-API • Graphics and multimedia • Events • Model-View-Control (MVC) • Threads • Internationalization, localization • Reflection • IO, Files • Tools (compiler, classloader, printer, ...) • Storage technologies (XML and serialization) • Distributed programming (sockets and RMI) • Databases (JDBC) • Compression • Security concepts

Alternatively, a single topic is explored in depth.
As part of the exercises, individual programming tasks or a larger programming task will be worked on. The tasks are related to the topic of the individual lecture contents.

Literaturempfehlungen	list of links in the learning management system
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	every semester
Module capacity	12
Reference text	
Teaching/Learning method	V+Ü
Previous knowledge	Object-oriented programming

Examination	Prüfungszeiten	Type of examination
Final exam of module	throughout the semester	practical exercises

Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		2	SoSe oder WiSe	56
Exercises		2	SoSe oder WiSe	28
Präsenzzeit Modul insgesamt				84 h

inf202 - Computer Engineering Practical

Module label	Computer Engineering Practical
Modulkürzel	inf202
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	

- Bachelor's Programme Biology (Bachelor) > Fachnahe Angebote Informatik
- Bachelor's Programme Business Administration and Law (Bachelor) > Fachnahe Angebote Informatik
- Bachelor's Programme Business Informatics (Bachelor) > Fachnahe Angebote Informatik
- Bachelor's Programme Chemistry (Bachelor) > Fachnahe Angebote Informatik
- Bachelor's Programme Comparative and European Law (Bachelor) > Fachnahe Angebote Informatik more...
- Bachelor's Programme Computing Science (Bachelor) > Fachnahe Angebote Informatik
- Bachelor's Programme Economics and Business Administration (Bachelor) > Fachnahe Angebote Informatik
- Bachelor's Programme Education (Bachelor) > Fachnahe Angebote Informatik
- Bachelor's Programme Engineering Physics (Bachelor) > Fachnahe Angebote Informatik
- Bachelor's Programme Environmental Science (Bachelor) > Fachnahe Angebote Informatik
- Bachelor's Programme Intercultural Education and Counselling (Bachelor) > Fachnahe Angebote Informatik
- Bachelor's Programme Mathematics (Bachelor) > Fachnahe Angebote Informatik
- Bachelor's Programme Physics (Bachelor) > Fachnahe Angebote Informatik
- Bachelor's Programme Physics, Engineering and Medicine (Bachelor) > Fachnahe Angebote Informatik
- Bachelor's Programme Social Studies (Bachelor) > Fachnahe Angebote Informatik
- Bachelor's Programme Sustainability Economics (Bachelor) > Fachnahe Angebote Informatik
- Dual-Subject Bachelor's Programme Art and Media (Bachelor) > Fachnahe Angebote Informatik
- Dual-Subject Bachelor's Programme Biology (Bachelor) > Fachnahe Angebote Informatik
- Dual-Subject Bachelor's Programme Chemistry (Bachelor) > Fachnahe Angebote Informatik
- Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Fachnahe Angebote Informatik
- Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Praktische Vertiefung (60 KP)
- Dual-Subject Bachelor's Programme Dutch Linguistics and Literary Studies (Bachelor) > Fachnahe Angebote Informatik
- Dual-Subject Bachelor's Programme Economic Education (Bachelor) > Fachnahe Angebote Informatik
- Dual-Subject Bachelor's Programme Economics and Business Administration (Bachelor) > Fachnahe Angebote Informatik
- Dual-Subject Bachelor's Programme Education (Bachelor) > Fachnahe Angebote Informatik
- Dual-Subject Bachelor's Programme Elementary Mathematics (Bachelor) > Fachnahe Angebote Informatik
- Dual-Subject Bachelor's Programme English Studies (Bachelor) > Fachnahe Angebote Informatik
- Dual-Subject Bachelor's Programme Gender Studies (Bachelor) > Fachnahe Angebote Informatik
- Dual-Subject Bachelor's Programme General Education (Bachelor) > Fachnahe Angebote Informatik
- Dual-Subject Bachelor's Programme German Studies (Bachelor) > Fachnahe Angebote Informatik
- Dual-Subject Bachelor's Programme History (Bachelor) > Fachnahe Angebote Informatik
- Dual-subject bachelor's programme Low German (Bachelor) > Fachnahe Angebote Informatik
- Dual-Subject Bachelor's Programme Material Culture: Textiles (Bachelor) > Fachnahe Angebote Informatik

	• Dual-Subject Bachelor's Programme Mathematics (Bachelor) > Fachnahe Angebote Informatik • Dual-Subject Bachelor's Programme Music (Bachelor) > Fachnahe Angebote Informatik • Dual-Subject Bachelor's Programme Philosophy / Values and Norms (Bachelor) > Fachnahe Angebote Informatik • Dual-Subject Bachelor's Programme Physics (Bachelor) > Fachnahe Angebote Informatik • Dual-Subject Bachelor's Programme Politics-Economics (Bachelor) > Fachnahe Angebote Informatik • Dual-Subject Bachelor's Programme Protestant Theology and Religious Education (Bachelor) > Fachnahe Angebote Informatik • Dual-Subject Bachelor's Programme Slavic Studies (Bachelor) > Fachnahe Angebote Informatik • Dual-Subject Bachelor's Programme Social Studies (Bachelor) > Fachnahe Angebote Informatik • Dual-Subject Bachelor's Programme Special Needs Education (Bachelor) > Fachnahe Angebote Informatik • Dual-Subject Bachelor's Programme Sport Science (Bachelor) > Fachnahe Angebote Informatik • Dual-Subject Bachelor's Programme Technology (Bachelor) > Fachnahe Angebote Informatik • Fach-Bachelor Pädagogisches Handeln in der Migrationsgesellschaft (Bachelor) > Fachnahe Angebote Informatik • Master of Education Programme (Gymnasium) Computing Science (Master of Education) > Wahlpflichtmodule (Technische Informatik) • Master of Education Programme (Hauptschule and Realschule) Computing Science (Master of Education) > Mastermodule • Master of Education Programme (Vocational and Business Education) Computing Science (Master of Education) > Praktische Vertiefung der Informatik
Zuständige Personen	• Fränzle, Martin Georg (module responsibility) • Janßen, Detlef (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	Recommendation: inf200 "Fundamentals of Computer Engineering
Skills to be acquired in this module	This course enables students to analyze information technology systems, understand individual components of computers, design and optimize them, and discuss domain-specific hardware design in a qualified manner. **Professional competences** The students • describe individual components of computers • design and optimize individual components of computers • design and optimize automata specify and imply autonomous systems **Methodological competence** The students • synthesize computer architectures • can transfer methods of hardware design to different systems **Social competence** The students • discuss hardware in a qualified manner **Self-competence** The students • are able to clearly distinguish their level of knowledge from professionals of related disciplines
Module contents	This module is the practical part of the course Introduction to Computer Engineering.
Literaturempfehlungen	• Script for the course • Patterson, D.A., Hennesy, J.L.: Computer Organisation and Design: The Hardware/Software Interface
Links	
Language of instruction	German

Duration (semesters)	1 Semester	
Module frequency	every summer term	
Module capacity	unlimited	
Teaching/Learning method	1 P	
Previous knowledge	Recommendation: inf200 Fundamentals of Computer Engineering	
Examination	Prüfungszeiten	Type of examination
Final exam of module	At the end of the lecture term	Portfolio
Lehrveranstaltungsform	Practical training	
SWS	4	
Frequency	SoSe	
Workload Präsenzzeit	56 h	

inf800 - Proseminar in Computer Science

Module label	Proseminar in Computer Science
Modulkürzel	inf800
Credit points	3.0 KP
Workload	90 h
Verwendbarkeit des Moduls	• Bachelor's Programme Business Informatics (Bachelor) > Aufbaucurriculum - Pflichtbereich • Bachelor's Programme Computing Science (Bachelor) > Aufbaumodule • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Praktische Vertiefung (60 KP) • Master of Education Programme (Vocational and Business Education) Computing Science (Master of Education) > Praktische Vertiefung der Informatik
Zuständige Personen	• Nieße, Astrid (module responsibility) • Sauer, Jürgen (module responsibility) • Diethelm, Ira (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	The specific participation requirements are described in the individual assigned courses.
Skills to be acquired in this module	Supported by a lecturer the students familiarise with a given topic by literature research. They understand and evaluate the relevance of the literature. After this evaluation the students present and discuss their solutions academically. **Professional competence** The students: • characterise and apply computer science basics (algorithms, data structures, programming, basics of practical, technical and theoretical computer science) • define und describe essential mathematical, logical and physical basics of computer science • define and illustrate the core disciplines of computer science (theoratical, practical and technical computer science) **Methodological competence** The students: • examine problems, use formal methods to phrase them and analyze them appropriately • evaluate problems by the use of technical and scientific literature • reflect on a scientific topic and write a scientific seminar paper under guidance and present their findings **Social competence** The students: • communicate considerately and appropriately with users and experts • use presentation methods **Self-competence** The students: • plan their informatical actions independently • reflect their contributions critically and discuss them with users and experts • collect and update their knowledge independently
Module contents	according to the assigned task
Literaturempfehlungen	
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	each semester
Module capacity	unlimited
Reference text	Students must attend one of the seminars offered.

	Passing the proseminar is a prerequisite for registering for the Bachelor's thesis.
Teaching/Learning method	S
Previous knowledge	none

Examination	Prüfungszeiten	Type of examination
Final exam of module	Am Ende des Semesters und nach Absprache	• Active participation in the seminar is expected • Paper and presentation

Lehrveranstaltungsform	Seminar
SWS	2
Frequency	SoSe oder WiSe
Workload Präsenzzeit	28 h

inf803 - Special Topics in Computer Science I

Module label	Special Topics in Computer Science I
Modulkürzel	inf803
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Business Informatics (Bachelor) > Akzentsetzungsbereich Praktische Informatik und Angewandte Informatik • Bachelor's Programme Computing Science (Bachelor) > Akzentsetzungsbereich - Wahlbereich Informatik • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Praktische Vertiefung (60 KP) • Master of Education Programme (Vocational and Business Education) Computing Science (Master of Education) > Praktische Vertiefung der Informatik
Zuständige Personen	• Diethelm, Ira (module responsibility) • Nieße, Astrid (module responsibility) • Sauer, Jürgen (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	The expected previous knowledge is specified in the details of the assigned course.
Skills to be acquired in this module	This module integrates current computer science developments within appropriate study courses. **Professional competence** The students: • know recent technological or scientific computer science developments • transfer computer science methods and development models to IT application area requirements • evaluate the possibilities and limitations of computer science methods and tools and apply them appropriately **Methodological competence** The students: • review problems, formulate them with formal models and explore them appropriately • identify and present (one or more) computer science problem solutions • select and evaluate appropriate tools and methods • examine problems with technical and scientific literature **Social competence** The students: • work in a team **Self-competence** The students: • plan their informatical actions independently
Module contents	According to the assigned course
Literaturempfehlungen	According to the assigned course
Links	
Languages of instruction	German, English

Duration (semesters)	1 Semester
Module frequency	semi-annual
Module capacity	unlimited
Reference text	Falls mehr dem Modul mehr als eine Veranstaltung zugeordnet ist, wählen Sie in der Regel Veranstaltungen im Gesamtumfang von 4 SWS aus, bspw. eine Vorlesung mit zugehöriger Übung. Weitere Informationen finden Sie in der Beschreibung (Details) der zugeordneten Veranstaltungen.
Teaching/Learning method	2 VA aus V, Ü, S, P, PR

Examination	Prüfungszeiten	Type of examination
Final exam of module		Exercises or presentation or oral exam or written exam

Lehrveranstaltungsform	VA-Auswahl
SWS	4
Frequency	siehe Angebotsrhythmus Modul
Workload Präsenzzeit	56 h

inf804 - Special Topics in Computer Science II

Module label	Special Topics in Computer Science II
Modulkürzel	inf804
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Business Informatics (Bachelor) > Akzentsetzungsbereich Praktische Informatik und Angewandte Informatik • Bachelor's Programme Computing Science (Bachelor) > Akzentsetzungsbereich - Wahlbereich Informatik • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Praktische Vertiefung (60 KP) • Master of Education Programme (Vocational and Business Education) Computing Science (Master of Education) > Praktische Vertiefung der Informatik
Zuständige Personen	• Diethelm, Ira (module responsibility) • Nieße, Astrid (module responsibility) • Sauer, Jürgen (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	The expected previous knowledge is specified in the details of the assigned course.
Skills to be acquired in this module	This module integrates current computer science developments within appropriate study courses. **Professional competence** The students: • know recent technological or scientific computer science developments • transfer computer science methods and development models to IT application area requirements • evaluate the possibilities and limitations of computer science methods and tools and apply them appropriately **Methodological competence** The students: • review problems, formulate them with formal models and explore them appropriately • identify and present (one or more) computer science problem solutions • select and evaluate appropriate tools and methods • examine problems with technical and scientific literature **Social competence** The students: • work in a team **Self-competence** The students: • plan their informatical actions independently
Module contents	According to the assigned course
Literaturempfehlungen	According to the assigned course
Links	
Languages of instruction	German, English

Duration (semesters)	1 Semester
Module frequency	irregularly
Module capacity	unlimited
Reference text	Falls mehr dem Modul mehr als eine Veranstaltung zugeordnet ist, wählen Sie in der Regel Veranstaltungen im Gesamtumfang von 4 SWS aus, bspw. eine Vorlesung mit zugehöriger Übung. Weitere Informationen finden Sie in der Beschreibung (Details) der zugeordneten Veranstaltungen.
Teaching/Learning method	2VA aus V, Ü, S, P, PR

Examination	Prüfungszeiten	Type of examination
Final exam of module		Exercises or presentation or oral exam or written exam

Lehrveranstaltungsform	VA-Auswahl
SWS	4
Frequency	siehe Angebotsrhythmus Modul
Workload Präsenzzeit	56 h

inf808 - Current Topics in Computer Science

Module label	Current Topics in Computer Science
Modulkürzel	inf808
Credit points	3.0 KP
Workload	90 h
Verwendbarkeit des Moduls	• Bachelor's Programme Business Informatics (Bachelor) > Akzentsetzungsbereich Praktische Informatik und Angewandte Informatik • Bachelor's Programme Computing Science (Bachelor) > Akzentsetzungsbereich - Wahlbereich Informatik • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Praktische Vertiefung (60 KP) • Master of Education Programme (Vocational and Business Education) Computing Science (Master of Education) > Praktische Vertiefung der Informatik
Zuständige Personen	• Diethelm, Ira (module responsibility) • Nieße, Astrid (module responsibility) • Sauer, Jürgen (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	Keine
Skills to be acquired in this module	This module integrates current computer science developments within appropriate study courses. **Professional competence** The students: • Know recent technological or scientific computer science developments • Transfer computer science methods and development models to IT application area requirements • Evaluate the possibilities and limits of computer science methods and tools and apply them appropriately **Methodological competence** The students: • Review problems, formulate them with formal models and explore them appropriately • Identify and present (one or more) computer science problem solutions • Select and evaluate appropriate tools and methods • Reflect on a scientific topic and write a scientific seminar paper under guidance and present their findings **Social competence** The students: • Use presentation methods purposefully **Self-competence** The students: • Plan their informatical actions independently • Reflect their contributions critically and discuss them with users and experts • Collect and update their knowledge independently
Module contents	According to the assigned task
Literaturempfehlungen	According to the assigned task

Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	unregelmäßig
Module capacity	unlimited
Teaching/Learning method	1 VA aus V, Ü, S, P, PR

Examination	Prüfungszeiten	Type of examination
Final exam of module		Exercises or presentation or oral exam or written exam

Lehrveranstaltungsform	VA-Auswahl
SWS	2
Frequency	siehe Angebotsrhythmus Modul
Workload Präsenzzeit	28 h

Wahlpflicht Technische Informatik (30 KP)

inf200 - Computer Engineering I

Module label	Computer Engineering I
Modulkürzel	inf200
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Computing Science (Bachelor) > Basismodule • Bachelor's Programme Mathematics (Bachelor) > Nebenfachmodule • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Basismodule • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Wahlpflicht Technische Informatik (30 KP) • Master of Education Programme (Vocational and Business Education) Computing Science (Master of Education) > Akzentsetzungsbereich
Zuständige Personen	• Rauh, Andreas (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	No participant requirements
Skills to be acquired in this module	he students learn to understand the construction of digital circuits and digital computers. They know the technological parameters, the state of the art technologies, and the developments characterizing current and future design paradigms for digital hardware. They learn to understand the concepts underlying current computer architectures and are able to explain how such architectures execute programs. Successful participants will be able to analyze computer architectures as a whole, to understand in depth, to analyze, and to optimize their hardware components, and to discuss the properties induced by selecting design alternatives. **Professional competences** The Students: • identify fundamental concepts of the construction of digital computer systems, the internal number representation, and analysis of combinational logic as well as their optimization. **Methological competences** The Students: • analyze computer architectures on the basis of their individual components • design and optimize digital hardware components • transfer systematic approaches of hardware design to unknown design problems **Social competences** The Students: • present their understanding of the functional principles of digital computer systems **Self-competences** The Students: • critically reflect on the results of exercises and recognize limitations of different approaches to the design of digital computer systems
Module contents	This module is the first part of the introduction to computer engineering. It explains the construction principles of computers, from the implementation of an easy Instruction Set Architecture, over fundamental techniques for coding and representation of numbers, program execution on machine level, basics of logics and analysis of functions of combinational logic as well as their optimization.
Literaturempfehlungen	• Lecture Notes • Schiffmann, W.; Schmitz, R. (2001): Technische Informatik I, II, Übungsbuch; Springer Verlag, Berlin.

- Dal Cin, M. (1996): Rechnerarchitektur; B.G. Teubner.
- Lagemann, K. (1987): Rechnerstrukturen; Springer-Verlag, Berlin.
- Oberschelp, W.; Vossen, G. (1989): Rechneraufbau und Rechnerstrukturen; Oldenbourg-Verlag.
- Mano, Morris M.(1993): Computer System Architecture 3; Prentice Hall.
- Gajski, D.(1997): Principles of Digital Design; Prentice Hall.
- Patterson, D.A.; Hennessy, J.L. (1997): Computer Organization and Design:
- The Hardware/Software Interface; 2. Edition; Morgan Kaufmann Publishers.
- Wilkinson, B. (1996): Computer Architecture Design and Performance; 2. Edition; Prentice Hall.
- Tanenbaum, A.S.(1999): Structured Computer Organization; 4. Edition; Prentice Hall.

Links				
Language of instruction		German		
Duration (semesters)		1 Semester		
Module frequency		annual		
Module capacity		unlimited		
Teaching/Learning method		1VL + 1Ü		
Previous knowledge		none		
Examination		Prüfungszeiten	Type of examination	
Final exam of module		At the end of the lecture term	Written or oral exam	
Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	WiSe	42
Exercises		1	WiSe	14
Präsenzzeit Modul insgesamt				56 h

inf201 - Computer Engineering II

Module label	Computer Engineering II
Modulkürzel	inf201
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Computing Science (Bachelor) > Aufbaumodule • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Wahlpflicht Technische Informatik (30 KP) • Master of Education Programme (Gymnasium) Computing Science (Master of Education) > Wahlpflichtmodule (Technische Informatik) • Master of Education Programme (Hauptschule and Realschule) Computing Science (Master of Education) > Mastermodule • Master of Education Programme (Vocational and Business Education) Computing Science (Master of Education) > Akzentsetzungsbereich
Zuständige Personen	• Rauh, Andreas (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	Knowledge of the module "Computer Engineering I"
Skills to be acquired in this module	The module qualifies students to analyze computer architectures, understand computer components, design and optimize computers and components, and to discuss domain-specific hardware design. **Professional Competences** The students: • describe computer components • design and optimise computer components • describe and analyse electric circuits **Methological Competences** The students: • analyse computer architectures • get familiar with fundamentals of the analysis and systhesis of flipflops and automata • get familiar with foundations of the analysis of electical circuits **Social Competences** The students: • discuss computer hardware and manufacturing processes competently • are able to transfer their knowledge of hardware design to other domains different from computer science **Self Competences** The students: • critically reflect the results of exercises and acknowledge limitations of various approaches for the design of computer systems
Module contents	This module is the second part of the introduction to computer engineering. It explains sequential circuits (e.g. flipflips and automata), arithmetic and logical computer components, registers and memory, basics of computer communication as well as electrotechnical foundations.
Literaturempfehlungen	• Lecture Notes • Oberschelp, W., Vossen, G.: Rechneraufbau und Rechnerstrukturen; Oldenbourg Verlag • Gajski, D.: Principles of Digital Design; Prentice Hall 1997 • Patterson, D.A., Hennesy, J.L.: Computer Organisation and Design: The Hardware/Software Interface; 2. Edition; Morgan Kaufman Publishers, 1997 • Tannenbaum, A.S.: Structured Computer Organization ; 4. Edition; Prentice Hall, 1999
Links	

Language of instruction		German		
Duration (semesters)		1 Semester		
Module frequency		annual		
Module capacity		unlimited		
Teaching/Learning method		V+Ü		
Previous knowledge		Knowledge of the module "Computer Engineering I"		
Examination	Prüfungszeiten		Type of examination	
Final exam of module	At the end of the lecture period		Written or oral Exam	

Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	SoSe	42
Exercises		1	SoSe	14
Präsenzzeit Modul insgesamt				56 h

inf203 - Embedded Systems I

Module label	Embedded Systems I
Modulkürzel	inf203
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Computing Science (Bachelor) > Akzentsetzungsbereich - Wahlbereich Informatik • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Wahlpflicht Technische Informatik (30 KP) • Master of Education Programme (Gymnasium) Computing Science (Master of Education) > Wahlpflichtmodule (Technische Informatik) • Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction • Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction • Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering
Zuständige Personen	• Fränzle, Martin Georg (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	• Basics of technical computer science • Computer Engineering
Skills to be acquired in this module	This module provides an introduction to the design of digital embedded systems. **Professional competence** The students: • name functional and non-functional requirements to specify embedded systems • discuss design space and associated embedded systems design methods • name control and feedback control systems' core concepts • characterise the fundamental digital signal processing algorithms **Methodological competence** The students: • design and develop embedded feedback control systems with modelling tools • implement an embedded hardware-/software system according to a given specification • analyze various specification languages according to different properties **Social competence** The students: • implement solutions to given problems in teams • present results of computer science problems to groups • organize themselves as a team to solve a larger problem using project management methods **Self-competence** The students: • acknowledge the limits of their ability to cope with pressure during the implementation process of systems • solve excercises self-responsibly
Module contents	Embedded systems support complex feedback problems, control problems and data processing tasks. They have an important value creation potential for telecommunications, production management, transport and electronics. The functionality of embedded systems is realised by the integration of processors, special hardware and software. The embedded systems design is influenced by the heterogeneity of system architectures, the complexity of systems and technical and economic requirements. This module gives an overview of embedded systems and their design. The process of digital signals is

	especially important for telecommunications and multimedia. For this purpose, the module introduces digital signal processing algorithms. The principles of feedback control are introduced by exemplary transport applications. Subsequently, the module provides the specifications and language characteristics of the embedded system design. For this purpose, graphical data-flow modelling languages (for instance Simulink) and control-flow specifications (for instance State Charts) are presented. The module closes with the concepts of possible architectures and communication models. Hands-on exercises with the tools Matlab/Simulink/StateFlow support the module contents.
Literaturempfehlungen	**Slides and:** • Harel, D.: STATECHARTS: A Visual Formalism for Complex Systems. Science of Computer Programming, 8, North-Holland, 1987, page(231-274) • Harel D.: Naamad, A. The STATEMATE Semantics of Statecharts. ACM Trans. Software Engineering Methods, Oct 1996 • Harel, D.; Politi, M.: Modeling Reactive Systems with Statecharts: The Statemate Approach • Josef Hoffmann: Matlab und Simulink: Beispielorientierte Einführung in die Simulation dynamischer Systeme, Addison-Wesley, 1998, ISBN 3-8273-1077-6 • Staunstrup, J., Wolf, W. (eds.): Hardware/Software Co-Design: Principles and Practice. Kluwer Academic Publishers, 1997, ISBN 0-7923-8013-4, chapters 1, 2, (3), 4, 6, (7), (8-10) • U. Reimers. Digitale Fernsehtechnik. 2. Aufl., Springer, 1997, ISBN 3-540-60945-8 **Secundary literature:** • Debardelaben, J.A.; Gadient, A.J.: Incorporating Cost Modeling in Embedded-System Design. IEEE Design & Test, vol 13, no. 3, 1997 • De Micheli, G.; Sami, M.: Hardware-Software Co-Design. Kluwer, 1996, ISBN 0-7923-3883-9 • Gajski, D.; Vahid, F.; Narayan, S.; Gong, J.: Specification and Design of Embedded Systems. Prentice Hall, 1994, ISBN 0-13-150731-1 • T. Painter, A. Spanias. Perceptual Coding of Digital Audio. Proceedings of the IEEE, vol 88, no 4, April 2000. • U. Freyer. DVB Digitales Fernsehen. Verlag Technik, 1997, ISBN 3-341-01192-7 • B. Friedrichs. Kanalcodierung: Grundlagen und Anwendungen in modernen Kommunikationssystemen. Springer, 1995, ISBN 3-540-58232-0 • G.C. Clark. Error-correction coding for digital communications. 3rd printing, Plenum Press, 1988, ISBN 0-306-40615-2 • Artikelserie zum MPEG-2-Standard 3/94 10/94 und das Tutorial "Digitale Bildcodierung" 1/92 1/93, beides in "Fernseh- und Kinotechnik" (BIS: Z elt ZA 1536)
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	annual
Module capacity	unlimited
Reference text	This module is compulsory for students who are specialising in "Eingebettete Systeme und Mikrorobotik". **Associaltes with the modules:** In the module "Eingebettete Systeme II" additonal relevant topics such as design processes, HW/SW-Partitioning, High-Level-Synthesis and Hardware discription languages are discussed. The modules Eingebettete Systeme I und II offer cross-references to the module "Rechnerarchitektur", "Realzeitbetriebssysteme" and semantic orientated modules of theoretical computer science. It is possible to enhance the knowledge of embedded systems design by attending the modules "System Level Design" and "Low energy System Design".
Teaching/Learning method	V+Ü
Previous knowledge	- Basics of technical computer science - Computer Engineering

Examination	Prüfungszeiten	Type of examination
Final exam of module	At the end of the semester	Written or oral exam

Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance

Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	WiSe	42
Exercises		1	WiSe	14
Präsenzzeit Modul insgesamt				56 h

inf204 - Embedded Systems II

Module label	Embedded Systems II
Modulkürzel	inf204
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Computing Science (Bachelor) > Akzentsetzungsbereich - Wahlbereich Informatik • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Wahlpflicht Technische Informatik (30 KP) • Master of Education Programme (Gymnasium) Computing Science (Master of Education) > Wahlpflichtmodule (Technische Informatik) • Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction • Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering
Zuständige Personen	• Fränzle, Martin Georg (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	No participant requirement
Skills to be acquired in this module	The module provides an introduction to digital embedded systems design. **Professional competence** The students: • name embedded systems architectures • name specific hardware components and -architecture designs, particularly processor designs • characterise the design spaces and associated embedded systems design techniques • decompose subcomponents of feedback control systems and implement their tasks in different design spaces • develop software-/hardware components • describe fault-tolerance architecture principles • describe real-time and safety requirements analysing techniques • characterise hardware synthesis **Methodological competence** The students: • estimate the consequences of design decisions in terms of energy usage, performance and reliability component allocations, and designs • implement an embedded hardware-/software system according to a given specification • model hardware with a hardware description languages - analyze Hardware-/Software systems using event-bases simulation **Social competence** The students: • implement solutions to given problems in teams • present results of computer science problems to groups • organize themselves as a team to solve a larger problem using project management methods **Self-competence** The students: • acknowledge the limits of their ability to cope with pressure during the implementation process of systems • deal self responsibly with exercises
Module contents	Embedded systems support complex feedback problems, control problems and data processing tasks. They have an important value creation potential for telecommunications, production management, transport and electronics. The functionality of embedded systems is realised by the integration of processors, special hardware and software. The embedded systems design is influenced by the heterogeneity of system architectures, the complexity of systems and technical and economic requirements. This module is the continuation of the module “Eingebettete Systeme I” and deals with different architectures of embedded systems and processors. The module provides system partitioning methods and the synthesis of hardware components. Hands-on exercises with development tools, hardware description languages and simulation support the

	module contents.
Literaturempfehlungen	**Slides and:** • Staunstrup, J.: Wolf, W. (eds.): Hardware/Software Co-Design: Principles and Practice. Kluwer Academic Publishers, 1997, ISBN 0-7923-8013-4, chapters 1, 2, (3), 4, 6, (7), (8-10) • Yen, Ti-Yen; Wolf, W.: Hardware-Software Co-Synthesis of Distributed Embedded Systems. Kluwer, 1996, ISBN 0-7923-9797-5 **Secondary literature:** • Peter J. Ashenden: The Designer's Guide to VHDL. Morgan Kaufmann Publishers, 2002, ISBN 1-55860-674-2 • Lehmann, G.; Wunder, B.; Selz, M.: Schaltungsdesign mit VHDL. Franzis Verlag, 1994, ISBN 3-7723-6163-3 • J. Reichardt, B. Schwarz: VHDL-Synthese, Entwurf digitaler Schaltungen und Systeme. Oldenbourg Wissenschaftsverlag, 2000, ISBN 3-486-25128-7 • Mermet, J. (ed.): Fundamentals and Standards in Hardware Description Languages. Kluwer, 1993, ISBN 0-7923-2513-3 • De Micheli, G.; Sami, M.: Hardware-Software Co-Design. Kluwer, 1996, ISBN 0-7923-3883-9 • Gajski, D.; Vahid, F.; Narayan, S.; Gong, J.: Specification and Design of Embedded Systems. Prentice Hall, 1994, ISBN 0-13-150731-1
Links	
Language of instruction	English
Duration (semesters)	1 Semester
Module frequency	annual
Module capacity	unlimited
Reference text	This module is supposed to be a compulsory module for students who are specialising in "Eingebettete Systeme und Mikrorobotik".
Teaching/Learning method	V+Ü
Previous knowledge	none

Examination	Prüfungszeiten	Type of examination
Final exam of module	At the end of the lecture times	Written or oral Exam

Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	SoSe	42
Exercises		1	SoSe	14
Präsenzzeit Modul insgesamt				56 h

inf205 - Formal Methods in Embedded System Design

Module label	Formal Methods in Embedded System Design
Modulkürzel	inf205
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Computing Science (Bachelor) > Akzentsetzungsbereich - Wahlbereich Informatik • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Wahlpflicht Technische Informatik (30 KP) • Master of Education Programme (Gymnasium) Computing Science (Master of Education) > Wahlpflichtmodule (Technische Informatik)
Zuständige Personen	• Fränzle, Martin Georg (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	Sound basic knowledge in mathematical logic, discrete mathematics, automata and computability theory as taught in the modules "Discrete Structures" and "Theoretical Computer Science I + II". In addition, programming skills as acquired in the "Programming Course". Justification: The methods presented in the lecture are based on an operationalization of semantics by reduction to logical encodings and mechanized testing of logical statements. An understanding of these contents as well as their tool-technical implementation requires the basics from the aforementioned courses.
Skills to be acquired in this module	The module provides an overview over semantic models for reactive systems, real-time systems ,and hybrid systems, as well as examples of corresponding specification logics. It explains state-exploratory verification procedures in both explicit and symbolic variants. The knowledge acquired can be employed in all domains requiring the development of reliable software and hardware systems is concerned **Professional competences** The students: • make a sound judgement on the scope of the certificates that can be obtained with formal methods • assess the suitability of available verification tools for a particular problem and system class • use automatic analysis tools on real systems, interpret the results obtained and subsequently improve the system under investigation in an informed and targeted manner • prepare system models for automatic analysis procedures and encode them symbolically (or otherwise) • design and implement their own verification algorithms **Methological competences** The students: • master the mathematical modelling of complex and heterogeneous dynamical systems • know relevant mathematical models of dynamic systems and can instantiate them to new problem classes **Social competences** The students: • together in a team develop and implement basic algorithms of automatic verification • discuss the advantages and disadvantages of algorithmic alternatives and different formalisations **Self competences** The Students: • can assess their technical and methodological understanding • reflect on their problem-solving competence with reference to the procedures and methods presented
Module contents	Embedded computer systems maintain constant interaction with their

environment. This induces interaction sequences that are difficult to predict, which complicates the construction and validation of such systems. Akin to the use of structural models for rigorous validation of building layouts in the construction industry, formal models in computer science have consequently been developed for analysis of various aspects of computing systems in general and embedded systems in particular. They cover execution time, energy demand, or possible system dynamics of embedded systems. They represent the respective aspect of the system in a closed form and thus allow for the - often fully automatic - derivation of reliable certificates that apply to any interaction scenario with the environment. This is in contrast to methods of testing or profiling, which only test selected scenarios and thus can only provide limited coverage.

In this module, various such models are explained and methods for their fully automatic analysis -i.e., derivation certificates- or synthesis -i.e., automatic generation of correct system designs- from such models are explained and demonstrated in their application.

The exercises provide opportunity for deepening understanding through hands-on experience with domain-specific modelling and verification

tools, as well as by creating a (small) fully automated verification tool yourself in a guided process.

In the lectures, the semantic, logical, and algorithmic basics of automatic analysis of embedded software systems are taught. The primary form of instruction is the media-supported lecture as well as the didactic question-answer game,.

In the exercise classes, the knowledge acquired in the lecture is deepened and put into practice. For this purpose, in the first half of the semester, exercises are set fortnightly, the completion of which in small groups encourages independent testing of the individual understanding of the topic and peer teaching. In the second half of the semester, a larger tool development task is set, also to be pursued on in small groups of 3 students each. The work on these projects spans the entire second half of the semester and offers the possibility of project-oriented learning. In this phase, the exercise classes serve as consultation time with the lecturers; in particular, solution approaches and problems can be presented and discussed.

Literaturempfehlungen

- Michael Huth, Mark Ryan: Logic in Computer Science: Modelling and Reasoning About Systems. Cambridge University Press, 2004.
- Christel Baier, Joost-Pieter Katoen: Principles of Model Checking. MIT Press, 2008.
- Edmund M. Clarke, Orna Grumberg, Doron A. Peled: Model Checking. MIT Press, 2000.

Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	annual
Module capacity	unlimited
Teaching/Learning method	V+Ü
Previous knowledge	Sound basic knowledge in mathematical logic, discrete mathematics, automata and computability theory as taught in the modules "Discrete Structures" and "Theoretical Computer Science I + II". In addition, programming skills as acquired in the "Programming Course". Justification: The methods presented in the lecture are based on an operationalization of semantics by reduction to logical encodings and mechanized testing of logical statements. An understanding of these contents as well as their tool-technical implementation requires the basics from the aforementioned courses.

Examination	Prüfungszeiten	Type of examination
Final exam of module	• 1st deadline: Submission of the semester project incl. one week after the end of the lecture period of the lecture period; followed by a colloquium and a final discussion • 2nd deadline: Repeat of the submission of the semester project incl. written elaboration	Semester project

Examination	Prüfungszeiten	Type of examination
	two weeks before the beginning of the following semester followed by colloquium and final discussion	

Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	WiSe	42
Exercises		1	WiSe	14
Präsenzzeit Modul insgesamt				56 h

inf207 - Electrical Engineering

Module label	Electrical Engineering
Modulkürzel	inf207
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Computing Science (Bachelor) > Akzentsetzungsbereich - Wahlbereich Informatik • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Wahlpflicht Technische Informatik (30 KP) • Master of Education Programme (Gymnasium) Computing Science (Master of Education) > Wahlpflichtmodule (Technische Informatik) • Master of Education Programme (Hauptschule and Realschule) Computing Science (Master of Education) > Mastermodule • Master's Programme Computing Science (Master) > Interdisziplinäre Module
Zuständige Personen	• Hein, Andreas (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	Module Analysis II or Numerics
Skills to be acquired in this module	**Professional competence:** The students: • analyse linear electrical networks (direct current and alternating current) • name basic concepts to calculate and to use electrical and magnetic fields • list the characteristics of simple electrical elements (two terminal networks) • calculate the parameters of simple electrical networks/wirings • apply computer based analysing tools • design and implement simple networks/wirings **Methodological competence:** The students: • transfer calculation methods onto complex dynamic systems • implement electrical system models **Social competence:** The students: • present solutions for specific questions **Self-competence:** The students: • reflect their solutions by using methods learned in this course
Module contents	• Basic concepts (electric dimensions and units) • Network elements • Calculation of linear direct current networks (Ohms law, Kirchhoff's circuit law, superposition principle) • Characteristics, calculations and representations of electric and magnetic fields • Construction elements (capacitor and coil) • Extensions of periodical dimensions dependent on time, pointer representation, calculations with complex root-mean-square value pointers
Literaturempfehlungen	**essential:** • slides • Albach: Grundlagen der Elektrotechnik 1 und 2. Pearson Studium, 2004. **recommended:** • Hagmann, G.: Grundlagen der Elektrotechnik. AULA-Verlag, 2002. • Hagmann, G.: Aufgabensammlung zu den Grundlagen der

Elektrotechnik. AULA-Verlag, 2002.

Links				
Language of instruction		German		
Duration (semesters)		1 Semester		
Module frequency		annual		
Module capacity		unlimited		
Teaching/Learning method		V+Ü		
Previous knowledge		Module Analysis II or Numerics		
Examination		Prüfungszeiten	Type of examination	
Final exam of module		At the End of the Semester	Hands-on exercises / written exam or oral exam	
Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	SoSe	42
Exercises		1	SoSe	14
Präsenzzeit Modul insgesamt				56 h

inf208 - Microrobotics and Microsystems Technology

Module label	Microrobotics and Microsystems Technology
Modulkürzel	inf208
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Computing Science (Bachelor) > Akzentsetzungsbereich - Wahlbereich Informatik • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Wahlpflicht Technische Informatik (30 KP) • Master of Education Programme (Gymnasium) Computing Science (Master of Education) > Wahlpflichtmodule (Technische Informatik) • Master's Programme Computing Science (Master) > Interdisziplinäre Module
Zuständige Personen	• Fatikow, Sergej (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	No participant requirements
Skills to be acquired in this module	Within the last few years, microrobotics and microsystem technology (MST) have become a focus of interest to industry and evolved into an important field with great application potential. It plays a decisive role for industry to be competitive in many areas such as medicine, production engineering, biotechnology, environmental technology, automotive products, etc. Despite of the growing interest in this new technology, there is hardly any book or lecture course that treats microrobotics and MST in a coherent and comprehensive way. This course is an attempt of the Microrobotics and Control Engineering Division (AMiR) to give students a systematic introduction to microrobotics and MST. It discusses all important aspects of this rapidly expanding technology, its diversity of products and fields of application. The course contains an overview of numerous ideas of new devices and the problems of manufacturing them. **Professional competence:** The students: • name the ideas, challenges and activities of microrobotics and microsystem technology • describe the microrobotics and MST applications • characterise MST methods • name microsensor functionality • characterise microsensor examples • discuss MST terms of information technology • classify microrobotics **Methodological competence** The students: • discover interdisciplinary connections and links between scientific and technical fields of research and development • learn technical abstraction of complex contexts **Social competence** The students: • solving problems partially as group • present their solutions and approaches to the group **Self-competence** The students: • reflect their knowledge of technical computer science • learn to expand on their professional competence independently
Module contents	**Ideas and problems of microrobotics and MST:** • applications; • techniques of MST; • silicon-based micromechanics; • LIGA technology; **Microactuators:** • principles and examples (electrostatic, piezoelectric, magnetostrictive, electromagnetic, SMA-based, thermomechanical, electrorheological

and other actuators);

Microsensors:

- principles and examples (force and pressure, position and speed, acceleration, biological and chemical, temperature and other sensors);
- MST and information processing;
- microsystem design and simulation;
- classification of microrobots;
- coarse positioning of a microrobot;
- fine positioning of a microrobot;

Handling of microparts:

- problems and solutions;
- micro grasp techniques;
- microassembly;

Process automation by microrobots:

- desktop robot cell in SEM

Literaturempfehlungen	**Essential:** • Vorlesungsskript in Buchform **Recommended:** • Fatikow, S.: Mikroroboter und Mikromontage, Teubner, Stuttgart Leipzig, 2000 • Fatikow, S./Rembold, U.: Microsystem Technology and Microrobotics, Springer, Berlin Heidelberg New York, 1997 • Menz, W. und Mohr, J.: Mikrosystemtechnik für Ingenieure, VCH, Weinheim, 1997 **Secondary Literature:** • Brück, A. und Schmidt, A.: Angewandte Mikrotechnik, Hanser, München Wien, 2001 • Ehrfeld, W. (Hrsg.): Handbuch Mikrotechnik, Hanser, München Wien, 2000 • Elbel, Th.: Mikrosensorik, Vieweg, Wiesbaden, 1996 • Fukuda, T. and Menz, W. (Eds.): Micro Mechanical Systems, Elsevier, Amsterdam, 1998 • Gardner, J.W.: Microsensors, Wiley, Chichester, 1994 • Gerlach, G. und Dötzel, W.: Grundlagen der Mikrosystemtechnik, Hanser, München Wien, 1997 • Krause, W.: Fertigung in der Feinwerk- und Mikrotechnik, Hanser, 1995 • Mescheder, U.: Mikrosystemtechnik, Teubner, Stuttgart Leipzig, 2000 • Tränkler, H.-R. und Obermeier, E. (Hrsg.): Sensortechnik, Springer, Berlin Heidelberg, 1998 • Völklein, F. und Zetterer, Th.: Einführung in die Mikrosystemtechnik, Vieweg, Wiesbaden, 2000
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	annual
Module capacity	unlimited
Reference text	**Associated with the modules:** • Embedded Systems and Microrobotics

Teaching/Learning method	V+Ü
Previous knowledge	none

Examination	Prüfungszeiten	Type of examination
Final exam of module	At the end of the semester	Oral exam in German

Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance

Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	WiSe	42
Exercises		1	WiSe	14
Präsenzzeit Modul insgesamt				56 h

inf209 - Control Theory

Module label	Control Theory
Modulkürzel	inf209
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Computing Science (Bachelor) > Akzentsetzungsbereich - Wahlbereich Informatik • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Wahlpflicht Technische Informatik (30 KP) • Master of Education Programme (Gymnasium) Computing Science (Master of Education) > Wahlpflichtmodule (Technische Informatik) • Master's Programme Computing Science (Master) > Interdisziplinäre Module
Zuständige Personen	• Fatikow, Sergej (module responsibility) • Hein, Andreas (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	• Differential Equations • Analysis II • Fundamentals of electrical engineering
Skills to be acquired in this module	Instruction on theoretical and mathematical basics of control engineering **Professional competence** The students: • describe the core principles of steering and control of technical systems • discuss the modelling core concepts of systems and their controllers • name methods to determine the quality of controlled systems • model technical systems with differential equations and their transfer functions • develop control structures, evaluate their stabilty and determine their optimal control parameters **Methodological competence** The students: • are aware of the technical challenges and solve them by including the implementations of other disciplines and methods **Social competence** The students: • present solutions for specific questions **Self-competence** The students: • get used to the specific challenges of the development of controlled systems
Module contents	**Basics** **analog transfer elements:** • linear time invariant (LTI-) systems; • simulation and modeling; • step response; • frequency response; • frequency response locus; • differential equations and transfer function; control loop stability; • types of controlled systems; • types of linear controllers; **linear control loops:** • reference and disturbance reaction of the controlled system; • rules for control loop optimization; • methods of analysis and synthesis, implementation; • computerbased control MATLAB/Simulink

Literaturempfehlungen	• Unbehauen, H.:Regelungstechnik I, Klassische Verfahren zur Analyse und Synthese linearer kontinuierlicher Regelsysteme • Lutz, H. und Wendt, W.:Taschenbuch der Regelungstechnik • further reading will be announced at lecture
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	annual
Module capacity	unlimited
Teaching/Learning method	V+Ü
Previous knowledge	- Differential Equations - Analysis II - Fundamentals of electrical engineering

Examination	Prüfungszeiten	Type of examination
Final exam of module	At the end of the lecture period	Hands-on exercises and written or oral exam

Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	WiSe	42
Exercises		1	WiSe	14
Präsenzzeit Modul insgesamt				56 h

inf210 - Signal and Image Processing

Module label	Signal and Image Processing
Modulkürzel	inf210
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Computing Science (Bachelor) > Akzentsetzungsbereich - Wahlbereich Informatik • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Wahlpflicht Technische Informatik (30 KP) • Master of Education Programme (Gymnasium) Computing Science (Master of Education) > Wahlpflichtmodule (Technische Informatik) • Master's Programme Computing Science (Master) > Interdisziplinäre Module
Zuständige Personen	• Hein, Andreas (module responsibility) • Fränzle, Martin Georg (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	Module math040 Analysis II b: Differential calculus of several variables
Skills to be acquired in this module	**Professional competence** The students: • name the concepts of signal and image processing in technical systems • name the methods/algorithms of preprocessing, filtering, classification, interpretation and visualisation of signals and pictures • Select algorithms appropriately • evaluate the effectiveness of algorithms • design algorithms and processing chains and evaluate their quality **Methodological competence** The students: • get used to specific subjects of signal and image processing **Social competence** The students: • present solutions for specific questions in signal and image processing **Self-competence** The students: • reflect their solutions by using methods learned in this course
Module contents	**Basic Concepts:** • Signal Processing • Signal Spaces and Signal Processing Systems • Discrete and Constant Signals • Labelling of Signal Transmitters with Test Signals • Representations Areas and Transformations • Time-Discrete Systems and Scanning • Estimation and Filtering • Construction with MATLAB • Image Processing **Introduction / Range of Applications:** • Functional Transformation • Image Enhancement/Filtering • Segmentation • 3D Reconstruction an Visualization
Literaturempfehlungen	**Essential:** • Foliensammlung zur Vorlesung **Recommended:** • Meyer, M.; Signalverarbeitung: Analoge und digitale Signale, Systeme und Filter

- Grüningen, D. C. v.; Digitale Signalverarbeitung: mit einer Einführung in die kontinuierlichen Signale und Systeme
- Tönnies, K.; Grundlagen der Bildverarbeitung; Pearson Studium 2005
- Lehmann, Th.; Oberschelp, W.; Pelinak, E.; Pepges, R.; Bildverarbeitung in der Medizin; Springer Verlag 1997
- Handels. H.; Medizinische Bildverarbeitung; Teubner Verlag, Stuttgart
- Leipzig 2000 weiterführende Literatur wird in der Vorlesung bekannt gegeben

Links				
Language of instruction		German		
Duration (semesters)		1 Semester		
Module frequency		annual		
Module capacity		unlimited		
Teaching/Learning method		V+Ü		
Previous knowledge		Module math040 Analysis II b: Differential calculus of several variables		
Examination		Prüfungszeiten	Type of examination	
Final exam of module		At the end of the semester	Hands-on exercises and written or oral exam	
Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		2	WiSe	28
Exercises		2	WiSe	28
Präsenzzeit Modul insgesamt				56 h

Wahlpflicht Theoretische Informatik (30 KP)

inf400 - Theoretical Computer Science: Logic

Module label	Theoretical Computer Science: Logic
Modulkürzel	inf400
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Computing Science (Bachelor) > Basismodule • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Wahlpflicht Theoretische Informatik (30 KP) • Master of Education Programme (Gymnasium) Computing Science (Master of Education) > Wahlpflichtmodule (Theoretische Informatik) • Master of Education Programme (Vocational and Business Education) Computing Science (Master of Education) > Akzentsetzungsbereich
Zuständige Personen	• Wehrheim, Heike (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	No participant requirements
Skills to be acquired in this module	Introduction to propositional logic, predicate logic, logic programming, and temporal logic **Professional competence** The students: • know syntax, semantics and applications of propositional logic, predicate logic, logic programming, and temporal logic • specify problems by using logical formulas • solve questions concerning propositional formulas with truth tables • draw conclusions in the field of propositional logic and predicate logic by means of natural deduction • answer queries to logic programs by using SLD resolution • perform model checking of Kripke structures with regard to CTL formulas algorithmically **Methodological competence** The students: • recognize logic as a versatile tool in computer science **Social competence** The students: • work together in small groups to solve problems • present solutions to problems to groups of other students **Self-competence** The students: • learn persistence in pursuing difficult tasks • learn precision in writing down solutions
Module contents	The course introduces propositional, predicate and temporal logic. In computer science it is essential to have a good understanding of logic because the language of logical formulas is widely used in the field of computer science. For example, Boolean expressions appear in every programming language and in circuit design; Horn clauses are used in knowledge representation; predicate logic and temporal logic are used for specifying software and hardware. More recent applications such as interactive and automatic proving as well as the logic programming language PROLOG emphasize the tool character of logic in computer science. The course introduces syntax, semantics, procedures, and calculi to prove the validity of formulas of propositional, predicate, and temporal logic. This is illustrated by many examples. Central is the concept of logical consequence. **Topics:** • propositional logic: syntax and semantics, truth tables, natural deduction • predicate logic: syntax and semantics, natural deduction • logic programming: declarative and procedural semantics, unification algorithm (Robinson), SLD resolution, PROLOG • temporal logic CTL: syntax and semantics of Kripke structures, CTL

model checking algorithm

Literaturempfehlungen	**Essential:** Script "Logik" (in German), in its current edition **Recommended:** D. van Dalen: "Logic and Structure", Fourth Edition. Springer-Verlag, 2004. **Good secondary reading:** U. Schöning: "Logic for Computer Scientists“, Birkhäuser, 1994.
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	annual
Module capacity	unlimited
Teaching/Learning method	V+Ü
Previous knowledge	none

Examination	Prüfungszeiten	Type of examination
Final exam of module	At the end of the lecture period	written exam or oral exam

Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	SoSe	42
Exercises		1	SoSe	14
Präsenzzeit Modul insgesamt				56 h

inf401 - Foundations of Theoretical Computer Science

Module label	Foundations of Theoretical Computer Science
Modulkürzel	inf401
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Computing Science (Bachelor) > Aufbaumodule • Bachelor's Programme Mathematics (Bachelor) > Nebenfachmodule • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Wahlpflicht Theoretische Informatik (30 KP) • Master of Education Programme (Gymnasium) Computing Science (Master of Education) > Pflichtmodule • Master of Education Programme (Hauptschule and Realschule) Computing Science (Master of Education) > Mastermodule • Master of Education Programme (Vocational and Business Education) Computing Science (Master of Education) > Akzentsetzungsbereich
Zuständige Personen	• Wehrheim, Heike (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	No participant requirement
Skills to be acquired in this module	Introduction to the theory of automata, formal languages, computability, and complexity **Professional competence** The students: • know different classes of languages (e.g. regular and context-free languages) • know automata models corresponding to the respective language classes (e.g. finite automata, pushdown automata, Turing machines) • construct automata, Turing machines, and grammars for given tasks • know equivalent formalisations of the concept of algorithm • classify functions as algorithmically computable and problems as algorithmically decidable • know and recognize undecidable problems • evaluate the complexity of algorithms • know problems that are solvable deterministically or nondeterministically in polynomial time **Methodological competence** The students: • learn about the power of abstract models of computation **Social competence** The students: • work together in small groups to solve problems • present solutions to problems to groups of other students **Self-competence** The students: • learn persistence in pursuing difficult tasks • learn precision in writing down solutions
Module contents	In the first part of the course, different classes of languages are introduced (regular and context-free languages). For each class a matching automata model is presented (finite automata, pushdown automata). Various properties are proven for the introduced classes of languages and models of automata. In the second part of the course, we examine which functions are computable and which problems are decidable. To this end, the concept of algorithm is formalised. Turing machines and grammars turn out as equivalent approaches. We show that there are problems that are undecidable. Many of these problems are of practical interest. The third part of the course deals with the complexity of algorithms, i.e. how much time and space is required to solve a problem. In particular, we consider problems that are solvable in polynomial time, either deterministically or non-deterministically. These problems are classified as P and NP.
Literaturempfehlungen	**Essential:** • Skript "Grundbegriffe der Theoretischen Informatik", jeweils in aktueller

Ausgabe

Recommended:

- Schöning: "Theoretische Informatik kurzgefasst", 5. Auflage, Spektrum, 2008

Good secondary literature:

- Hopcroft, Motwani, Ullman: "Einführung in die Automatentheorie, Formale Sprachen und Komplexitätstheorie", Pearson, 2002 (ein Klassiker...)

Links				
Language of instruction		German		
Duration (semesters)		1 Semester		
Module frequency		annual		
Module capacity		unlimited		
Teaching/Learning method		V+Ü		
Previous knowledge		none		
Examination	Prüfungszeiten		Type of examination	
Final exam of module	At the end of the lecture period		Written or oral exam	
Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	WiSe	42
Exercises		1	WiSe	14
Präsenzzeit Modul insgesamt				56 h

inf407 - Program Verification

Module label	Program Verification
Modulkürzel	inf407
Credit points	6.0 KP
Workload	180 h
Verwendbarkeit des Moduls	• Bachelor's Programme Computing Science (Bachelor) > Akzentsetzungsbereich - Wahlbereich Informatik • Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Wahlpflicht Theoretische Informatik (30 KP) • Master of Education Programme (Gymnasium) Computing Science (Master of Education) > Wahlpflichtmodule (Theoretische Informatik)
Zuständige Personen	• Wehrheim, Heike (module responsibility) • Olderog, Ernst-Rüdiger (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	Theoretical computer science I and II
Skills to be acquired in this module	Introduction to methods for proving the correctness of sequential, parallel, and distributed programs. **Professional competence** The students: • describe operational semantics of sequential, parallel, and distributed programs - Know the concepts of partial and total correctness of programs • establish soundness and completeness of proof systems • construct input-output specifications of programs • conduct correctness proofs for programs of different classes with the help of proof rules • check interference and deadlock freedom of parallel programs • transform parallel and distributed programs into nondeterministic programs **Methodological competence** The students: • recognize correctness as an important aspect of programs and informatics systems **Social competence** The students: • work together in small groups to solve problems • present their solutions to groups of other students **Self-competence** The students: • learn persistence in pursuing difficult tasks • learn precision in specifying problems
Module contents	Program verification is a systematic approach to show the absence of errors in programs. For this purpose desirable behavioural properties of a given program are proven. For instance, a sorting program should only deliver sorted arrays. Partial correctness, termination, and the absence of runtime errors are essential for sequential programs. Additional behavioural properties are of interest for parallel programs: absence of interference, absence of deadlocks, and fair behaviour. The module focuses on the verification of parallel programs. For this purpose classic methods of Hoare's logic are combined with more recent techniques of program transformation. Sequential programs are covered in preparation for this.
Literaturempfehlungen	**essential:** • "K.R. Apt, E.-R. Olderog, Programmverifikation, Springer-Verlag, 1994" **Or the extended English version:** • "K.R. Apt, F.S. de Boer, E.-R. Olderog, Verfication of Sequential and Concurrent Programs, Third Edition, Springer-Verlag, 2008"
Links	

Language of instruction		German		
Duration (semesters)		1 Semester		
Module frequency		irregular		
Module capacity		unlimited		
Teaching/Learning method		1VL + 1Ü		
Previous knowledge		Theoretical computer science I and II		
Examination		Prüfungszeiten	Type of examination	
Final exam of module		At the end of the lecture period	Written exam or oral exam	
Lehrveranstaltungsform	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	siehe Angebotsrhythmus Modul	42
Exercises		1	siehe Angebotsrhythmus Modul	14
Präsenzzeit Modul insgesamt				56 h

Abschlussmodul

bam - Bachelor Thesis and Colloquium

Module label	Bachelor Thesis and Colloquium
Modulkürzel	bam
Credit points	15.0 KP
Workload	450 h
Verwendbarkeit des Moduls	• Dual-Subject Bachelor's Programme Computing Science (Bachelor) > Abschlussmodul
Zuständige Personen	• Diethelm, Ira (module responsibility) • Lehrenden, Die im Modul (Prüfungsberechtigt)
Prerequisites	No participant requirements
Skills to be acquired in this module	The students are able to process and write on a scientifically oriented computer science topic. **Professional competence** The students: • evaluate the possibilities and limits of computer science methods and tools and apply them appropriately **Methodological competence** The students: • select appropriate methods and tools and evaluate them • analyse problems using the latest technical and scientific literature • implement software projects and design hardware with the latest computer science tools • reflect a (computer) science topic under guidance, write an article (seminar paper or thesis) and present their results scientifically **Social competence** The students: • recognise conflicts and solve them in a team • use presentation and project management methods appropriately • identify and assume responsibility for tasks • are aware of the social impact of their computational/informatical actions, as well as the consequences of information technologies **Self-competence** The students: • select priorities appropriately, also their own • plan their computer science actions independently Complement and deepen their knowledge and adapt it to the latest developments in IT independently • evaluate their results and discuss them with users and experts
Module contents	A state-of-the-art computer science topic is processed theoretically, scientifically and practically. The student presents the results.
Literaturempfehlungen	According to the topic
Links	Please contact the student advisory service! Some groups publish information and forms on their web pages.
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	every semester
Module capacity	unlimited
Teaching/Learning method	1S
Previous knowledge	none

Examination	Prüfungszeiten	Type of examination
Final exam of module	varying	thesis, seminar paper
Lehrveranstaltungsform	Seminar	

SWS	2
Frequency	SoSe und WiSe
Workload Präsenzzeit	28 h