Module manual for the Examination regulations (FPO-M) for the subject

Computer Science (INF)

in the master's program

at the University of Siegen

From September 2021

- **Inofficial translation** -

No.	4INFMA001			
Module title	Scientific Working			
Responsible for the module	Prof. Dr. Roland Wismüller			
Teacher	Prof. Dr. Andreas Kolb, Professors and staff of the Department ETI			
Faculty	IV			
Compulsory/elective	Compulsory			
Module duration	1-2 semesters			
Frequency of supply	Lecture: every summer semester; seminar: every semester			
Recommended semester	s. study plan			
Teaching language	German/English			
Credit points	9			
SWS	3			
Presence study	45 h			
Self-study	225 h			
Workload	270 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Scientific Working	60	1	3 CP
Seminar	Master seminar	30	2	6 CP
Performance requirements	**Form**			**Duration/Scope**
Examination	Overall examination performance consisting of the examination elements: Seminar talk (50 %) with Seminar paper (50 %)			 30 min. 5000 words
Study achievements	Active and regular participation			At least 80% of the event dates
Qualification goals	Students can • use literature databases and other sources to develop material on a given topic, • read, understand, analyze and prepare original literature in English, • draft a talk on a complex scientific topic (including didactically correct design) and deliver it in front of an expert audience using customary media, • critically question or defend facts in a discussion, • produce texts explaining technical/scientific issues on 10-20 pages, • follow the principles of good scientific practice, • assess the visibility of a scientific paper and of scientific publication channels (journals, proceedings, etc.), • reproduce the main features of the process of producing a scientific publication, including the reviewing and publication process. Since, in addition to technical competence, the ability to present and discuss scientific issues is to be learned and practiced, regular on-site attendance is mandatory.			
Contents	In the module element "Scientific Working", the basic features of (self-) organization in scientific work itself, as well as in connection with researching the state of research, preparing a publication, and submitting and reviewing it are discussed. In addition, the principles of good scientific practice are dealt with. In the module element "Master's Seminar", with changing subject-related topics, which build on teaching materials from the previous subject-related semesters, are developed by the students, prepared in writing and presented in a presentation. The subject-related content is secondary to the targeted methodological skills and key qualifications and can, if necessary, complement a focus chosen in the elective area.			

Applicability in the following courses of study	MA Computer Science
Requirements for participation	---
Prerequisites for the award of credit points	Passed examination and passed study achievements.
Literature	
Other information	

Examination-related special features of the above-mentioned module description when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA002			
Module title	Cutting Edge Research			
Responsible for the module	Prof. Dr. Andreas Kolb			
Teacher	Professors and staff of the Department ETI			
Faculty	IV			
Compulsory/elective	Compulsory			
Module duration	1 semester			
Frequency of supply	Every winter semester			
Recommended semester	s. study plan			
Teaching language	English			
Credit points	6			
SWS	2			
Presence study	30 h			
Self-study	150 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Cutting Edge Research	60	2	
Performance requirements	**Form**			**Duration/Scope**
Examination	---			
Study achievements	Two course credits: term paper and Active and regular participation			 20 pages At least 12 dates
Qualification goals	After completing this module, students will be able to understand the basics and basic concepts of the research presented to such an extent that they can actively and successfully participate in their evaluation or further development in the context of a seminar, a project thesis or a master's thesis. In addition, the ability to engage in scientific discussion is to be learned and practiced, which makes regular on-site participation imperative.			
Contents	The Cutting Edge Research module is offered in the form of a lecture series. Within the framework of weekly lectures, professors and employees of computer science chairs present the basic concepts, ideas and results of current research projects at the University of Siegen; if necessary, their theoretical, conceptual and practical foundations are also conveyed. In the context of a subsequent discussion round, the students can address open questions and problems of the respective lecture topic and discuss application potentials, further development possibilities and limits of the presented techniques and solutions. For a selected part of the lecture topics, the students prepare a summarizing and evaluating paper, which is to be submitted after the end of the lecture series in the lecture-free period.			
Applicability in the following courses of study	MA Computer Science			
Requirements for participation	---			
Prerequisites for the award of credit points	Passed study achievements			
Literature				
Other information				

No.	4INFMA003			
Module title	Project Work			
Responsible for the module	Prof. Dr. Roland Wismüller			
Teacher	Professors and staff of the Department ETI			
Faculty	IV			
Compulsory/elective	Compulsory			
Module duration	2 semesters			
Frequency of supply	Every semester			
Recommended semester	from 2			
Teaching language	German/English			
Credit points	15			
SWS	0			
Presence study	0 h			
Self-study	450 h			
Workload	450 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Project work	Project work	1-8		
Performance requirements	**Form**	**Duration/Scope**		***Preliminary CP***
Examination	Project work	450 h		6 CP
Study achievements	Project reports	60-120 min		9 CP
Qualification goals	Technical qualification • Students will be able to analyze and evaluate in-depth and specific technical topics of the assignment and design and evaluate their own solutions based on their acquired knowledge. Key skills • Ability to work in a team; the tasks of a project can usually only be fulfilled with a division of the workload. The project participants must divide up the work on their own responsibility, regularly monitor and discuss the progress of the work, plan the further procedure, prepare appropriate protocols and use organizational techniques, recognize and rectify any faults and problems that may occur. • Communication with users: in many cases the task is to implement a system for real users who are not engineers, who do not know the relevant technical terms and who are not able to assess the technologies. • The ability to use literature databases and other sources to locate material on a given topic. • If applicable, the ability to read and understand demanding original English literature. • The ability to design a presentation on a non-trivial scientific topic in front of a specialist audience (i.e. also to design it didactically correctly) and to deliver it using standard media. • The ability to write a report of approx. 30 - 200 pages (depending on the number of participants) in a group, in which the results of the project work are presented.			
Contents	The participants in a project work group collaborate on a complex task that is relevant to their course of study and usually originates from a research project of the organizer. The work is carried out in a team consisting of students and, if applicable, researchers from the organizing department.			

	The problem is specifically described by the organizer in a project description, which is handed out to the participants before the start of the project work. The project description specifies above all the minimum goal to be achieved for the successful completion of the project group. With regard to the motivation of the participants, the problem should be as close to reality as possible; interdisciplinary topics are permitted; an external product or deadline constraint must be excluded.
Applicability in the following courses of study	MA Computer Science
Requirements for participation	---
Prerequisites for the award of credit points	Passed examination performance and passed study performance.
Literature	
Other information	

Examination-related special features of the above-mentioned module description when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA004			
Module title	Master Thesis Computer Science			
Responsible for the module	Prof. Dr. Roland Wismüller			
Teacher	Professors and staff of the Department ETI			
Faculty	IV			
Compulsory/elective	Compulsory			
Module duration	1 semester			
Frequency of supply	Every semester			
Recommended semester	4			
Teaching language	German/English			
Credit points	30			
SWS	0			
Presence study	0 h			
Self-study	900 h			
Workload	900 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Performance requirements	**Form**			**Duration/Scope**
Examination	Overall examination performance consisting of the examination elements: Master thesis (75 %) and Colloquium (25 %) (presentation followed by discussion)			 26 weeks, max. 120 pages 20 min + 10-20 min
Study achievements	---			
Qualification goals	Students can • independently conduct a literature search on a given scientific topic using literature databases and other sources, • Read, understand, and evaluate challenging original English-language literature in relation to the assignment, • analyze, evaluate, plan and/or implement extensive software and/or hardware systems in a project-oriented manner, • draft a presentation on a challenging scientific topic (i.e. also design it didactically correctly) and deliver it in front of a professional audience using common media, • prepare a text explaining technical/scientific matters of 60-120 pages.			
Contents	In the final thesis, the candidate must independently work on a challenging problem in his or her field of study within a given period of time using scientific methods and present it orally and in writing.			
Applicability in the following courses of study	MA Computer Science			
Requirements for participation	Content: / Formal: Attainment of at least 60 credit points; no examination performance with only a single retake attempt			
Prerequisites for the award of credit points	Passed Exam Performance.			
Literature				
Other information				

No.	4INFMA020			
Module title	Software Engineering II			
Responsible for the module	Prof. Dr. Malte Lochau			
Teacher	Prof. Dr. Malte Lochau			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every summer semester			
Recommended semester	From 1			
Teaching language	German			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group Size**	**SWS**	***if necessary Workload/ CP***
Lecture	Software Engineering II	60	2	
Exercise	Software Engineering II	30	2	
Performance requirements	**Form**			**Duration/Scope**
Examination	Oral examination or written test The form of the examination performance will be announced no later than four weeks after the start of the course.			30 min. 90 min.
Study achievements	---			
Qualification goals	Upon completion of the module, students will be able to - be able to select, explain and apply procedures and tools for systematic quality assurance appropriately, - be able to select concepts, methods and tools for model-based software development, evaluate them and apply them in practice in a goal-oriented manner, - Understand, explain, maintain and enhance existing complex software systems through the use of appropriate techniques and tools.			
Contents	Building on the Software Engineering I module, the module focuses on the development as well as the maintenance and quality assurance of complex and safety-critical software systems. The focal points include: - Quality assurance with a focus on testing, - Model-based software design and model-driven software development (metamodeling and model transformations, domain-specific languages), - Reengineering, reverse engineering, refactoring, reuse - Design and architecture patterns, software product lines, - Semantics of modeling languages.			
Applicability in the following courses of study	MA Computer Science in the teaching profession for HRSGe MA Computer Science in the teaching profession for GymGe MA Computer Science in the teaching profession for BK-A MA Computer Science MA Business Informatics			
Requirements for participation	Content: The module 4INFBA007 "Software Engineering I" should have been completed successfully. Formal: /			
Prerequisites for the award of credit points	Passed examination performance			
Literature				
Other information				

Special features of the above-mentioned module description with regard to examination law when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**
Oral supplementary examination possible	**Yes:** ☐ ☐ ☐ **No:** ☐
Repeat examination for grade improvement possible	**Yes:** ☐ **No:** ☐
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**

No.	4INFMA021			
Module title	Modeling and Animation			
Responsible for the module	Prof. Dr. Volker Blanz			
Teacher	Prof. Dr. Volker Blanz			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every summer semester			
Recommended semester	From 1			
Teaching language	English			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	*if necessary Workload/ CP*
Lecture	Modeling and Animation	60	2	
Exercise	Modeling and Animation	30	2	
Performance requirements	**Form**	**Duration/Scope**		*Preliminary CP*
Examination	Written examination	120 min.		4 CP
Study achievements	Successful completion of exercise or project tasks	approx. 12 tasks, approx. 45 h		2 CP
Qualification goals	The student understands modeling and animation techniques for computer graphics, can evaluate them and use and implement them in simple programs.			
Contents	Freeform curves and surfaces, subdivision surfaces, modeling techniques, keyframe and spline animation, skeletal animation, procedural animation, collision detection.			
Applicability in the following courses of study	BA Computer Science BA Dual Study Computer Science MA Computer Science in the teaching profession for HRSGe MA Computer Science in the teaching profession for GymGe MA Computer Science in the teaching profession for BK-A MA Computer Science MA Mathematics			
Requirements for participation	Content: The modules 4INFBA020 "Introduction to Visual Computing" and 4INFBA200 "Computer Graphics" should have been successfully completed. Formal: Admission to the examination requires passing the course work in this module.			
Prerequisites for the award of credit points	Passed examination performance and passed study performance.			
Literature				
Other information				

Examination-related special features of the above-mentioned module description when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA023			
Module title	Computer Architecture II			
Responsible for the module	Prof. Dr. Roman Obermaisser			
Teacher	Dr. Michael Wahl			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Annual winter semester			
Recommended semester	From 1			
Teaching language	English			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Computer Architecture II	60	2	
Exercise	Computer Architecture II	30	1	
Seminar	Computer Architecture II	30	1	
Performance requirements	**Form**	**Duration/Scope**		***Preliminary CP***
Examination	Oral examination	20-40 min		4 CP
Study achievements	Seminar presentation with elaboration	15 min., 2500 words		2 CP
Qualification goals	In the lecture part, the students receive an overview of different architectures for special requirements. Based on this knowledge, the students should be able to determine an architecture that corresponds to the task. In the seminar, students should use the knowledge they have gained to independently develop new architectural features based on current publications.			
Contents	Architecture development of general purpose processors, instruction sets, performance enhancing processing, parallel processing, advanced arithmetic, architectures for special requirements, e.g. graphics processing, digital signal processing and automotive.			
Applicability in the following courses of study	Master Electrical Engineering MA Computer Science in the teaching profession for HRSGe MA Computer Science in the teaching profession for GymGe MA Computer Science in the teaching profession for BK-A MA Computer Science			
Requirements for participation	Content: The module 4INFBA010 "Computer Architectures I" should have been completed successfully. Formal: Admission to the examination requires passing the course work in this module.			
Prerequisites for the award of credit points	Passed examination performance and passed study performance.			
Literature				
Other information				

Special features of the above-mentioned module description with regard to examination law when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA024			
Module title	Parallel Processing			
Responsible for the module	Prof. Dr. Roland Wismüller			
Teacher	Prof. Dr. Roland Wismüller			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every winter semester			
Recommended semester	From 1			
Teaching language	German/English			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Parallel Processing	60	2	
Practical Lab Course	Parallel Processing	30	2	
Performance requirements	**Form**	**Duration/Scope**		***Preliminary CP***
Examination	Oral examination or Written test The form of the examination performance will be announced no later than four weeks after the start of the course.	40 min. 60 min.		4 CP
Study achievements	Successful completion of exercise or project tasks	4 tasks, approx. 45 h		2 CP
Qualification goals	Students can apply the various techniques of parallel processing and assess their specific strengths and weaknesses. They can solve practical problems with relevant standards, libraries and tools. They can assess for given applications whether parallelization makes sense and which techniques should be used if necessary. They are able to identify the parts in existing sequential programs that can be parallelized and to construct parallel code for these parts. Students will be able to correctly apply relevant methods in the design of parallel programs, especially in performance estimation, problem partitioning and the actual parallelization.			
Contents	Parallel processing is a fundamental technique for increasing the performance or throughput of hardware and software. The course imparts theoretical and practical knowledge about the different techniques of parallel processing, with an emphasis on practical application. The module includes a practical course in which the participants independently parallelize smaller programs using different techniques. Specifically, the following topics are covered: • Basics: parallelism, parallel computer architectures, parallelization strategies, data dependencies • Parallel programming with memory coupling: threads, OpenMP, parallel libraries and languages • Parallel programming with message coupling: MPI			
Applicability in the following courses of study	MA Computer Science in the teaching profession for HRSGe MA Computer Science in the teaching profession for GymGe MA Computer Science in the teaching profession for BK-A MA Computer Science MA Business Informatics MA Mathematics			

Requirements for participation	Content: The modules 4INFBA003 "Algorithms and Data Structures", 4INFBA004 "Object Orientation and Functional Programming", 4INFBA011 "Operating Systems and Concurrent Programming" and 4INFBA010 "Computer Architecture I" should have been successfully completed. Formal: /
Prerequisites for the award of credit points	Passed examination performance and passed study performance.
Literature	
Other information	

Special features of the above-mentioned module description with regard to examination law when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA025			
Module title	Computer Networks II			
Responsible for the module	Prof. Dr. Roland Wismüller			
Teacher	Prof. Dr. Roland Wismüller			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every summer semester			
Recommended semester	From 1			
Teaching language	German			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Computer Networks II	60	2	
Exercise	Computer Networks II	30	2	
Performance requirements	**Form**			**Duration/Scope**
Examination	Oral examination			20-40 min.
Study achievements	---			
Qualification goals	Upon completion of the module, students will be able to - explain and evaluate the operation of common network technologies, including wireless networks. - explain the tasks and functionality of the protocols (especially multicast, routing and multimedia protocols) and mechanisms (especially congestion avoidance and QoS) used on the Internet and analyze problems that occur and their solutions. - create simple programs for network communication - Assess the strengths and weaknesses of various network technologies, evaluate them against given requirements or applications, and select appropriate technologies.			
Contents	The module provides an in-depth insight into important and current network technologies and protocols, with a focus on Ethernet, wireless networks and the Internet protocol family. Topics covered include WAN technologies, WLAN, Bluetooth, advanced IP routing (e.g. multicast, MPLS), IP security, congestion control and prevention, QoS, network programming and multimedia protocols. Furthermore, outlooks into more specific and current topics are given, e.g. SDN, real-time Ethernet or wireless sensor networks.			
Applicability in the following courses of study	MA Computer Science in the teaching profession for HRSGe MA Computer Science in the teaching profession for GymGe MA Computer Science in the teaching profession for BK-A MA Computer Science MA Business Informatics			
Requirements for participation	Content: The module 4INFBA012 "Computer Networks I" should have been completed successfully. Formal: /			
Prerequisites for the award of credit points	Passed examination performance			
Literature	L.L. Peterson, B.S. Davie. Computer networks - a system approach. Morgan Kaufman. A. Tanenbaum, D.J. Wetherall, Computer Networks, Pearson J.F. Kurose, K.W. Ross. Computer networking - a top-down approach. Pearson			
Other information				

Special features of the above-mentioned module description with regard to examination law when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA026			
Module title	Advanced Logic			
Responsible for the module	Prof. Dr. Markus Lohrey			
Teacher	Prof. Dr. Markus Lohrey			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every summer semester			
Recommended semester	From 1			
Teaching language	German/English			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Advanced Logic	60	2	
Exercise	Advanced Logic	30	2	
Performance requirements	**Form**			**Duration/Scope**
Examination	Oral examination			20-40 minutes
Study achievements	---			
Qualification goals	The students * understand the basic limitations of formal methods * master basic techniques for deciding logical Theories * understand the relationship between logic and automata			
Contents	* Undecidability of satisfiability for predicate logic (Theorem of Church) * Trakhtenbrot's theorem on finite satisfiability * Undecidability of arithmetic * Gödel's incompleteness theorem * Automatic structures * Decidability of Presburger arithmetic * Decidability of real arithmetic * Monadic 2nd order logic (MSO) * Büchi's theorem (equivalence of finite automata and MSO)			
Applicability in the following courses of study	MA Computer Science in the teaching profession for HRSGe MA Computer Science in the teaching profession for GymGe MA Computer Science in the teaching profession for BK-A MA Computer Science MA Mathematics			
Requirements for participation	Content: The modules 4INFBA005 "Formal Languages and Automata" and 4INFBA006 "Computability and Logic" should have been successfully completed. Formal: /			
Prerequisites for the award of credit points	Passed examination performance			
Literature				
Other information				

Special features of the above-mentioned module description with regard to examination law when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA028			
Module title	Algorithmics I			
Responsible for the module	Prof. Dr. Markus Lohrey			
Teacher	Prof. Dr. Markus Lohrey			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every winter semester			
Recommended semester	From 1			
Teaching language	German/English			
Credit points	6			
SWS	3			
Presence study	45 h			
Self-study	135 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Algorithmics I	60	2	
Exercise	Algorithmics I	30	1	
Performance requirements	**Form**	**Duration/Scope**		***Preliminary CP***
Examination	Written examination	60 minutes		4 CP
Study achievements	Successful completion of exercise or project tasks	1 task, approx. 10h		2 CP
Qualification goals	Students master basic analysis techniques and design principles and can apply these to concrete algorithmic problems.			
Contents	* Divide-and-conquer algorithms * Greedy algorithms * Dynamic programming * Algorithms for words, trees and graphs * Sorting algorithms * basic data structures (e.g. binary search trees)			
Applicability in the following courses of study	MA Computer Science in the teaching profession for HRSGe MA Computer Science in the teaching profession for GymGe MA Computer Science in the teaching profession for BK-A MA Computer Science MA Mathematics			
Requirements for participation	---			
Prerequisites for the award of credit points	Passed examination performance and passed course performance			
Literature				
Other information				

Special features of the above-mentioned module description with regard to examination law when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA029

Module title	Database systems II			
Responsible for the module	Univ.-Prof. Dr. Malte Lochau			
Teacher	Univ.-Prof. Dr. Malte Lochau			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every summer semester			
Recommended semester	From 1			
Teaching language	German			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Database systems II	60	2	
Exercise	Database systems II	30	2	
Performance requirements	**Form**			**Duration/Scope**
Examination	Oral exam or written exam The form of the examination performance will be announced no later than four weeks after the start of the course.			30 min. 90 min.
Study achievements	---			
Qualification goals	Upon completion of the module, students will be able to • Understand and apply the concepts of XML and graph databases (GDB), • be able to evaluate and assess the application areas of XML and GDB, • formulate simple queries and transformation rules on XML and GDB, • explain implementation techniques for XML and GDB and apply them to simple examples.			
Contents	By way of introduction, the limitations of relational database systems are discussed and compared with the basic concepts of XML and graph databases (GDB). The following topics are then discussed in more detail: • XML: Data definition with DTD, XML schema • XML: Queries Xpath, XQuery, XSLT • GDB: Data definition with RDF, LPG • GDB: Requests Neo4J/Cypher, SPARQL			
Applicability in the following courses of study	MA Computer Science MA Computer Science in the teaching profession for HRSGe MA Computer Science in the teaching profession for GymGe MA Computer Science in the teaching profession for BK-A MA Business Informatics			
Requirements for participation	Content: The module 4INFBA008 "Database Systems I" should have been completed successfully. Formal: /			
Prerequisites for the award of credit points	Passed examination performance			
Literature				
Other information				

Examination-related special features of the above-mentioned module description when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	*** see Article 2 § 10 paragraph 3 FPO-M INF**			

No.	4INFMA100			
Module title	Development of Embedded Systems using FPGAs			
Responsible for the module	Prof. Dr. Roman Obermaisser			
Teacher	Dipl.-Ing. Veit Wiese			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every winter semester			
Recommended semester	From 1			
Teaching language	English			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Development of Embedded Systems using FPGAs	60	2	
Exercise	Development of Embedded Systems using FPGAs	30	2	
Performance requirements	**Form**	**Duration/Scope**		***Preliminary CP***
Examination	Written examination	120 min.		4 CP
Study achievements	Successful completion of exercise or project tasks	approx. 12 tasks, approx. 30 h		2 CP
Qualification goals	This course provides students with the ability to design embedded systems using field programmable gate arrays. The aim of this module is to enable students to identify requirements and design the hardware and software architecture. In addition, students will learn how to simulate the design, implement and validate the functionality of embedded systems.			
Contents	• Introduction (what are embedded systems, properties of such systems, what is an FPGA) • Processing units (what is a processor, hardcore vs. softcore, ARM processors, softcore processors) • Memory (non-volatile memory: Flash, SD card, volatile memory: SRAM, BRAM, DDR, cache memory, DMAs) • Communication systems (off-chip and on-chip solutions, buses and NoCs, AMBA bus (AXI), OCP, shared memory) • Man-machine interfaces (timers and counters, keyboards, LEDs, displays, barcode readers) • Embedded software (what is BSP? Bare Metal Application, • Hardware/software co-design (state machines, introduction to Verilog) • Validation and debugging (debugging techniques, error injection)			
Applicability in the following courses of study	BA Computer Science BA Dual Study Computer Science MA Computer Science			
Requirements for participation	Content: The modules 4INFBA009 "Digital Technology" and 4INFBA010 "Computer Architectures I" should have been successfully completed. Formal: Admission to the examination requires passing the course work in this module.			
Prerequisites for the award of credit points	Passed examination performance and passed study performance.			
Literature				
Other information				

Special features of the above-mentioned module description with regard to examination law when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA101			
Module title	Internship Ubiquitous Systems			
Responsible for the module	Univ.-Prof. Kristof Van Laerhoven			
Teacher	Florian Wolling			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every semester			
Recommended semester	From 1			
Teaching language	English			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	*if necessary Workload/ CP*
Lecture	Internship Ubiquitous Systems	60	1	
Internship	Internship Ubiquitous Systems	30	3	
Performance requirements	**Form**			**Duration/Scope**
Examination	Term paper (final report)			20 pages
Study achievements	---			
Qualification goals	Students develop an understanding of efficiency in the field of embedded systems and become familiar with the design, development and implementation of efficient software. They are able to create structured and hardware-oriented programs and master the handling of complex data sheets and manuals.			
Contents	Hardware-oriented programming in C of energy-efficient ultra-low power microcontrollers. Core topics covered include signal input and output, polling and interrupts, timers, and power management.			
Applicability in the following courses of study	BA Computer Science BA Dual Study Computer Science MA Computer Science			
Requirements for participation	Content: Knowledge of the programming language C. Formal: /			
Prerequisites for the award of credit points	Passed examination performance			
Literature				
Other information				

Examination-related special features of the above-mentioned module description when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA102			
Module title	Storage technologies			
Responsible for the module	Dr. Michael Wahl			
Teacher	Dr. Michael Wahl			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every summer semester			
Recommended semester	From 1			
Teaching language	English/German			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	*if necessary Workload/ CP*
Lecture	Storage technologies	60	2	
Exercise	Storage technologies	30	1	
Seminar	Storage technologies	30	1	
Performance requirements	**Form**	**Duration/Scope**		*Preliminary CP*
Examination	Oral examination	20-40 min.		4 CP
Study achievements	Seminar presentation with elaboration	20 min., 5 pages		2 CP
Qualification goals	After completion of the module - know the memory pyramid from register, cache, main memory and mass storage to archive systems, - have gained an overview of the various methods of storage on rotating media, with a view to the future also being essential, - have understood where the limits of storage density on hard disks are, - are able to explain volatile and non-volatile memories and to explain the technologies and - have learned to distinguish well between values that are possible in the ideal case and those that occur in practice, e.g. in the case of interfaces.			
Contents	Rotating memory: - Basics of data storage - Writing and reading methods and their performance limits - Interfaces Solid state storage: - Methods for storing individual bits, such as SRAM, DRAM, FeRAM,... - Semiconductor memory architectures - Interfaces			
Applicability in the following courses of study	Master Electrical Engineering MA Computer Science			
Requirements for participation	Content: The modules 4INFBA009 "Digital Technology" and 4INFBA010 "Computer Architectures I" should have been successfully completed. Formal: Admission to the examination requires passing the course work in this module.			
Prerequisites for the award of credit points	Passed examination performance and passed study performance.			
Literature				
Other information				

Special features of the above-mentioned module description with regard to examination law when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA197			
Module title	Foreign Module Embedded Systems I			
Responsible for the module	Prof. Dr. Roland Wismüller			
Teacher				
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Irregular			
Recommended semester	From 2			
Teaching language	country-specific			
Credit points	6			
SWS				
Presence study				
Self-study				
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
According to the host university				
Performance requirements	**Form**			**Duration/Scope**
Examination	According to the host university			
Study achievements	According to the host university			
Qualification goals	Students acquire further qualifications at a foreign university that enable them to understand and apply concepts, methods and tools in the field of embedded systems that are not taught at the University of Siegen or not to the corresponding extent.			
Contents	The concrete contents of this module depend on the receiving university. They are to be determined prior to the stay abroad, whereby a significant overlapping of content with other modules is to be excluded. The subsequent recognition of the work performed abroad must be ensured in advance by means of a learning agreement.			
Applicability in the following courses of study				
Requirements for participation	---			
Prerequisites for the award of credit points	Passing the module at the host university. Learning Agreement for the recognition of achievements.			
Literature				
Other information				

No.	4INFMA198			
Module title	Foreign Module Embedded Systems II			
Responsible for the module	Prof. Dr. Roland Wismüller			
Teacher				
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Irregular			
Recommended semester	From 2			
Teaching language	country-specific			
Credit points	6			
SWS				
Presence study				
Self-study				
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
According to the host university				
Performance requirements	**Form**			**Duration/Scope**
Examination	According to the host university			
Study achievements	According to the host university			
Qualification goals	Students acquire further qualifications at a foreign university that enable them to understand and apply concepts, methods and tools in the field of embedded systems that are not taught at the University of Siegen or not to the corresponding extent.			
Contents	The concrete contents of this module depend on the receiving university. They are to be determined prior to the stay abroad, whereby a significant overlapping of content with other modules is to be excluded. The subsequent recognition of the work performed abroad must be ensured in advance by means of a learning agreement.			
Applicability in the following courses of study				
Requirements for participation	---			
Prerequisites for the award of credit points	Passing the module at the host university. Learning Agreement for the recognition of achievements.			
Literature				
Other information				

No.	4INFMA199			
Module title	Foreign Module Embedded Systems III			
Responsible for the module	Prof. Dr. Roland Wismüller			
Teacher				
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Irregular			
Recommended semester	From 2			
Teaching language	country-specific			
Credit points	6			
SWS				
Presence study				
Self-study				
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
According to the host university				
Performance requirements	**Form**			**Duration/Scope**
Examination	According to the host university			
Study achievements	According to the host university			
Qualification goals	Students acquire further qualifications at a foreign university that enable them to understand and apply concepts, methods and tools in the field of embedded systems that are not taught at the University of Siegen or not to the corresponding extent.			
Contents	The concrete contents of this module depend on the receiving university. They are to be determined prior to the stay abroad, whereby a significant overlapping of content with other modules is to be excluded. The subsequent recognition of the work performed abroad must be ensured in advance by means of a learning agreement.			
Applicability in the following courses of study				
Requirements for participation	---			
Prerequisites for the award of credit points	Passing the module at the host university. Learning Agreement for the recognition of achievements.			
Literature				
Other information				

No.	4INFMA200			
Module title	Rendering			
Responsible for the module	Dr. Martin Lambers			
Teacher	Dr. Martin Lambers			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	every semester			
Recommended semester	From 1			
Teaching language	English			
Credit points	6			
SWS	3			
Presence study	45 h			
Self-study	135 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	*if necessary Workload/ CP*
Lecture	Rendering	60	2	
Exercise	Rendering	30	1	
Performance requirements	**Form**	**Duration/Scope**		*Preliminary CP*
Examination	Oral examination	20-40 min.		4 CP
Study achievements	Successful completion of exercise or project tasks	1 task, approx. 30 h		2 CP
Qualification goals	The student understands the listed methods of image synthesis and physically based rendering, can describe and evaluate them and use and implement them in simple programs.			
Contents	Physically based rendering, complex material models and BRDFs, global illumination, Monte-Carlo methods, image based rendering, point based rendering.			
Applicability in the following courses of study	BA Computer Science BA Dual Study Computer Science MA Computer Science			
Requirements for participation	Content: The modules 4INFBA020 "Introduction to Visual Computing" and 4INFBA200 "Computer Graphics" should have been successfully completed. Formal: /			
Prerequisites for the award of credit points	Passed examination performance and passed study performance.			
Literature				
Other information				

Special features of the above-mentioned module description with regard to examination law when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**		
Oral supplementary examination possible	**Yes:**		**After each attempt:** / **After the last try:**
	No:	**X**	
Repeat examination for grade improvement possible	**Yes:**	**X***	
	No:		
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**		

No.	4INFMA201			
Module title	GPU Programming			
Responsible for the module	Dr. Martin Lambers			
Teacher	Dr. Martin Lambers			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	every winter semester			
Recommended semester	From 1			
Teaching language	English			
Credit points	6			
SWS	3			
Presence study	45 h			
Self-study	135 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	*if necessary Workload/ CP*
Lecture	GPU Programming	60	1	
Practical Lab Course	GPU Programming	30	2	
Performance requirements	**Form**	**Duration/Scope**		*Preliminary CP*
Examination	Oral examination	20-40 min.		4 CP
Study achievements	Successful completion of exercise or project tasks	1 task, approx. 30 h		2 CP
Qualification goals	The student understands concepts of graphics processing units as well as selected algorithms, can describe and evaluate them and use and implement them in simple programs.			
Contents	Concepts of Graphics Processing Units (GPUs), GPU resource management and execution model, thread cooperation, memory models, selected algorithms, advanced GPU features, GPU programming interface			
Applicability in the following courses of study	MA Computer Science			
Requirements for participation	Content: / Formal: Admission to the examination requires passing the course work in this module.			
Prerequisites for the award of credit points	Passed examination performance and passed study performance.			
Literature				
Other information				

Examination-related special features of the above-mentioned module description when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA202			
Module title	Scientific Visualization			
Responsible for the module	Prof. Dr. Andreas Kolb			
Teacher	Prof. Dr. Andreas Kolb			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	every winter semester			
Recommended semester	From 1			
Teaching language	English			
Credit points	6			
SWS	3			
Presence study	45 h			
Self-study	135 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	*if necessary Workload/ CP*
Lecture	Scientific Visualization	60	2	
Exercise	Scientific Visualization	30	1	
Performance requirements	**Form**	**Duration/Scope**		*Preliminary CP*
Examination	Oral examination	20-40 min.		4 CP
Study achievements	Successful completion of exercise or project tasks	1 task, approx. 30 h		2 CP
Qualification goals	The student understands visualization methods, can describe and evaluate them and use and implement them in simple programs.			
Contents	Grids and interpolation, triangulation, 2D scalar fields, 2D vector fields, 3D vector fields, indirect and direct volume visualization			
Applicability in the following courses of study	BA Computer Science BA Dual Study Computer Science MA Computer Science			
Requirements for participation	Content: The modules 4INFBA020 "Introduction to Visual Computing" and 4INFBA200 "Computer Graphics" should have been successfully completed. Formal: /			
Prerequisites for the award of credit points	Passed examination performance and passed study performance.			
Literature				
Other information				

Special features of the above-mentioned module description with regard to examination law when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA203			
Module title	Statistical Learning Theory			
Responsible for the module	Prof. Dr. Volker Blanz			
Teacher				
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every summer semester			
Recommended semester	From 1			
Teaching language	English			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Statistical Learning Theory	60	2	
Exercise	Statistical Learning Theory	30	2	
Performance requirements	**Form**			**Duration/Scope**
Examination	Oral examination			20 - 40 min.
Study achievements	---			
Qualification goals	The lecture broadens and deepens the knowledge gained from the lecture *Machine Learning*. The students develop a mathematically more profound understanding of the learning problem and get to know methods that are more theoretically motivated. Nevertheless, the lecture remains application-oriented: only methods and concepts are treated that are of practical relevance and that, together with those from the *Machine Learning* lecture, belong to the basic repertoire of modern AI. In all contents of the lecture, the intuitive understanding and the ability to evaluate are the main focus.			

Contents	The lecture starts with some basic considerations on learning theory, a general formulation in terms of risk minimization and VC dimension, followed by a selection of the most important learning methods of supervised and unsupervised learning, as far as they have not already been covered in *Machine Learning:*
	• Algorithm-independent properties: Curse of Dimensionality, No-free-lunch Theorem
	• Risk minimization, VC Dimension, Support Vector Machines, Kernel methods
	• Neural Networks revisited:
	  ○ Transfer Learning
	  ○ Long Short Term Memory LSTM
	  ○ Current developments
	• Density estimation, clustering method
	• Gaussian Mixture Models
	• Hidden Markov Models
	• Graphical Models, Bayes Networks, Decision Trees
	• Application examples from different areas			

Applicability in the following courses of study	BA Computer Science BA Dual Study Computer Science MA Computer Science MA Mathematics			
Requirements for participation	Content: The module 4INFBA013 "Machine Learning" should have been completed successfully. Formal: /			
Prerequisites for the award of credit points	Passed examination performance			

Literature	Duda, Hart, Stork. Pattern Clasification, 2ed. Wiley 2001 V. Vapnik. The nature of statistical learning theory. Springer 1999
Other information	

Special features of the above-mentioned module description with regard to examination law when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA204			
Module title	Deep Learning			
Responsible for the module	Prof. Dr. Michael Möller			
Teacher	Prof. Dr. Michael Möller			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every winter semester			
Recommended semester	From 1			
Teaching language	English			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Deep Learning	60	2	
Exercise	Deep Learning	30	2	
Performance requirements	**Form**	**Duration/Scope**		***Preliminary CP***
Examination	Written examination	90 min.		4 CP
Study achievements	Successful completion of exercise or project tasks	approx. 12 tasks, approx. 45 h		2 CP
Qualification goals	Upon completion of this module, students understand the basic concepts of deep learning. They can analyze the chain rule for nested functions with several variables and are able to implement the gradient descent algorithm for simple networks from scratch. Students are familiar with a deep learning framework and can implement architectures for regression and classification problems on their own. Students are familiar with different design patterns for the architecture of neural networks, and can explain crucial steps for the successful training and generalization of neural networks.			
Contents	The following topics will be covered in this module: - Supervised machine learning as a function approximation problem - Simple network architectures: Fully connected layers, activation functions - Gradient descent for nested functions: The chain rule and its implementation via backpropagation - Stochastic gradient descent on large data sets, accelerations - Training, testing, and validation data sets - Strategies for successful training and generalization - State-of-the-art architecture design - Practical experience in numerical implementations			
Applicability in the following courses of study	MA Computer Science MA Mathematics			
Requirements for participation	Content: Knowledge of linear algebra, calculus and programming is assumed. Additionally, students should have prior knowledge in machine learning. Formal: Admission to the examination requires passing the course work in this module.			
Prerequisites for the award of credit points	Passed examination performance and passed study performance.			
Literature				
Other information				

Examination-related special features of the above-mentioned module description when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA205			
Module title	Recent Advances in Machine Learning			
Responsible for the module	Prof. Dr. Michael Möller			
Teacher				
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every summer semester			
Recommended semester	From 1			
Teaching language	English			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Recent Advances in Machine Learning	60	2	
Project work	Recent Advances in Machine Learning	30	2	
Performance requirements	**Form**			**Duration/Scope**
Examination	---			
Study achievements	Seminar presentation with elaboration			20 min., 5 pages
Qualification goals	Upon completion of this module, students have an understanding of some exemplary state-of-the-art research papers on machine learning. They are able to explain their main ideas and concepts. Students are familiar with at least one machine learning framework and are able to implement machine learning problems on their own. Additionally, each student specializes by working on research project for which she/he is able to understand, explain, analyze and evaluate the used techniques. The students are able to run practical experiments for the studied method.			
Contents	This module presents recent advances in machine learning in different fields of data sciences, e.g. imaging, vision, graphics, mechatronics, and sensorics. It addresses advanced techniques in the fields of machine learning, deep learning and artificial intelligence, with a particular focus on recent research papers, novel application areas and open questions in the aforementioned fields. Based on basic prior knowledge gained in other courses, this module specifically focuses on the state-of-the-art in machine learning by introducing recent publications from the leading international conferences on machine learning, computer vision, or their application in fields like computer graphics, 3D reconstruction, robotics, navigation, medicine, or body-worn sensorics. After covering the theory of such works, a project phase will ask every student to implement and apply one of the discussed techniques.			
Applicability in the following courses of study	MA Computer Science MA Mathematics			
Requirements for participation	Content: Knowledge of machine learning is assumed. Formal: /			
Prerequisites for the award of credit points	Passed study achievements			
Literature				
Other information				

No.	4INFMA206			
Module title	Convex Optimization for Computer Vision			
Responsible for the module	Prof. Dr. Michael Möller			
Teacher	Prof. Dr. Michael Möller			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every summer semester			
Recommended semester	From 1			
Teaching language	English			
Credit points	6			
SWS	5			
Presence study	75 h			
Self-study	105 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Convex Optimization for Computer Vision	60	3	
Exercise	Convex Optimization for Computer Vision	30	2	
Performance requirements	**Form**	**Duration/Scope**		***Preliminary CP***
Examination	Oral examination	20-40 min.		4 CP
Study achievements	Successful completion of exercise or project tasks	approx. 12 tasks, approx. 30 h		2 CP
Qualification goals	Upon completion of this module, students will be proficient in the practically relevant aspects of convex analysis. They are able to understand, apply and implement different numerical methods for convex optimization problems involving constraints and non-differentiable functions. The students are also able to reformulate energy minimization problems in a saddle-point and dual form. They will understand the convergence analysis of the proximal point algorithm and can apply the result to several other algorithms by deriving their proximal point form. Students will be able to solve convex optimization problems arising from standard computer vision problems on their own.			
Contents	Convex analysis as the theoretical basis for all algorithms: - Convexity - Existence and uniqueness of minimizers - subdifferentials - Convex conjugates - Saddle point problems and duality Numerical methods: - Gradient Descent - Proximal Gradient Descent - Proximal point algorithm - Primal-dual methods - Example applications in computer vision and signal processing problems: - Implementation of the optimization algorithms for image denoising, deblurring, and reconstruction problems			
Applicability in the following courses of study	MA Computer Science MA Business Analytics			
Requirements for participation	Content: Solid knowledge of linear algebra and calculus is assumed. Formal: Admission to the examination requires passing the course work in this module.			
Prerequisites for the award of credit points	Passed examination performance and passed study performance.			
Literature	- Lecture notes. - Stephen Boyd, Lieven Vandenberghe. Convex Optimization. Cambridge University Press. 2003. - R. Tyrrell Rockafellar. Convex analysis. Princeton University Press. 1970.			

	- Jean-Baptiste Hiriart-Urruty, Claude Lemaréchal. Fundamentals of convex analysis. Springer. 2004. - Yurii Nesterov. Introductory lectures on convex optimization. Kluwer-Academic. 2003. - Convex Analysis and Monotone Operator Theory in Hilbert Spaces. H. H. Bauschke and P. L. Combettes. 2011. - Jorge Nocedal, Stephen J. Wright. Numerical optimization. - Dimitri Bertsekas. Nonlinear programming. Athena Scientific. 1999. Further references to recent literature will be given in the lecture.
Other information	

Special features of the above-mentioned module description with regard to examination law when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA207			
Module title	Numerical Methods for Visual Computing			
Responsible for the module	Prof. Dr. Michael Möller			
Teacher	Prof. Dr. Michael Möller			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every winter semester			
Recommended semester	From 1			
Teaching language	English			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Numerical Methods for Visual Computing	60	2	
Exercise	Numerical Methods for Visual Computing	30	2	
Performance requirements	**Form**	**Duration/Scope**		***Preliminary CP***
Examination	Oral examination	20-40 min.		4 CP
Study achievements	Successful completion of exercise or project tasks	approx. 12 tasks, approx. 45 h		2 CP
Qualification goals	Upon completion of this module, students understand, are able to apply and implement numerical methods for basic tasks arising in data sciences. They understand sources of errors in their computations and are aware of the condition of algorithms. Students can reduce exemplary visual computing problems to more abstract mathematical problems and solve them with suitable algorithms.			
Contents	The following topics will be covered in this module: - Error analysis, rounding errors, error amplification, catastrophic cancellation - Gaussian normal equation, minimal-norm solutions - Solving linear equations exactly as well as iteratively - Numerical methods for computing eigenvectors and eigenvalues - Fixed-point iterations for solving nonlinear equations - Solving interpolation problems - Numerical integration - Practical implementation of the above numerical methods for the example applications			
Applicability in the following courses of study	BA Computer Science BA Dual Study Computer Science MA Computer Science			
Requirements for participation	Content: Knowledge of linear algebra and calculus is assumed. Formal: Admission to the examination requires passing the course work in this module.			
Prerequisites for the award of credit points	Passed examination performance and passed study performance.			
Literature				
Other information				

Examination-related special features of the above-mentioned module description when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA208			
Module title	Machine Vision			
Responsible for the module	Prof. Dr. Volker Blanz			
Teacher				
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	summer semester			
Recommended semester	From 1			
Teaching language	English			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Machine Vision	60	2	
Exercise	Machine Vision	30	2	
Performance requirements	**Form**			**Duration/Scope**
Examination	Oral examination			20-40 min.
Study achievements	---			
Qualification goals	The lecture provides a deeper understanding of the *problem of* vision and the underlying mechanisms of image formation and image analysis. It avoids any *black boxes* as solution approaches and thus positions itself as the antithesis to many statistical procedures of pattern recognition. Students learn not only to know the basic procedures, but also to analyze them and assess them in terms of theoretical and practical advantages and disadvantages. The students apply the simpler of the procedures themselves in the context of practice by implementing example programs. They develop an understanding of the historical development of the research field and become sensitized to the challenges of machine vision, its opportunities and current limitations.			
Contents	The lecture deals with two classical problems of machine vision: the inference of 3D structure from 2D image data, and automatic face recognition. • Theories of vision, vision as inverse optics, • Brief summary of edge and feature detectors • Camera models, homogeneous coordinates, calibration • depth sensors (time-of-flight methods, triangulation) stereo algorithms, correspondence problem, epipolar geometry, fundamental matrix, multi-view geometry • Image rectification, use of the pseudo inverses • Overview of personal identification procedures • Eigenfaces, PCA • Deformable models in 2D and 3D: Active Appearance Models, Morphable Models • Evaluation criteria for classification procedures, ROC curves			
Applicability in the following courses of study	MA Computer Science MA Mathematics			
Requirements for participation	---			
Prerequisites for the award of credit points	Passed examination performance			
Literature	Forsyth and Ponce: Computer Vision (Prentice Hall) Hartley and Zisserman: Multiple View Geometry (Cambridge University Press)			

	Li and Jain: Handbook of Face Recognition (Springer)
Other information	

Examination-related special features of the above-mentioned module description when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA210			
Module title	Virtual Reality			
Responsible for the module	Prof. Dr. Andreas Kolb			
Teacher	Prof. Dr. Andreas Kolb			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	every semester			
Recommended semester	From 1			
Teaching language	English			
Credit points	6			
SWS	3			
Presence study	45 h			
Self-study	135 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	*if necessary Workload/ CP*
Lecture	Virtual Reality	60	1	
Practical Exercise	Virtual Reality	30	2	
Performance requirements	**Form**	**Duration/Scope**		*Preliminary CP*
Examination	Oral examination	20-40 min.		4 CP
Study achievements	Successful completion of exercise or project tasks	1 task, approx. 30 h		2 CP
Qualification goals	The student understands concepts and techniques of Virtual Reality, can evaluate them and use and implement them in simple programs.			
Contents	Human perception, VR hardware, VR software frameworks, level of detail techniques, interaction/selection/manipulation/navigation, aspects of Augmented Reality.			
Applicability in the following courses of study	MA Computer Science			
Requirements for participation	Content: The modules 4INFBA020 "Introduction to Visual Computing" and 4INFBA200 "Computer Graphics" should have been successfully completed. Formal: /			
Prerequisites for the award of credit points	Passed examination performance and passed study performance.			
Literature				
Other information				

Special features of the above-mentioned module description with regard to examination law when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA211			
Module title	Higher Level Computer Vision			
Responsible for the module	Prof. Dr.-Ing. Margret Keuper			
Teacher	Prof. Dr.-Ing. Margret Keuper			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	irregular			
Recommended semester	From 1			
Teaching language	English			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Higher Level Computer Vision	60	2	
Exercise	Higher Level Computer Vision	30	2	
Performance requirements	**Form**			**Duration/Scope**
Examination	Oral examination			20-40 min.
Study achievements	---			
Qualification goals	• Deep understanding of current computer vision methods for image classification, object detection, image segmentation, image generation and domain transfer. • Understand, apply and evaluate current approaches. • Understanding of the technical principles of computer vision methods. • Evaluation and discussion of new computer vision problems and methods.			
Contents	Current issues, methods and datasets in computer vision for image classification, object detection, image segmentation, image generation and domain transfer.			
Applicability in the following courses of study	MA Computer Science			
Requirements for participation	Content: Basic knowledge of linear algebra and python is assumed. Formal: /			
Prerequisites for the award of credit points	Passed examination performance			
Literature	• R. Szeliski: Computer Vision Algorithms and Applications, Springer, 2010. ISBN: 978-1-84882-934-3. (Online available: http://szeliski.org/Book/). • Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning, An MIT press book, 2016.			
Other information				

Special features of the above-mentioned module description with regard to examination law when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA212			
Module title	Unsupervised Learning			
Responsible for the module	Prof. Dr.-Ing. Margret Keuper			
Teacher	Prof. Dr.-Ing. Margret Keuper			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	irregular			
Recommended semester	From 1			
Teaching language	English			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Unsupervised Learning	60	2	
Exercise	Unsupervised Learning	30	2	
Performance requirements	**Form**			**Duration/Scope**
Examination	Oral examination			20-40 min.
Study achievements	---			
Qualification goals	• Deep understanding of current methods of unsupervised learning of image and text representations, self-supervised learning, representation learning, generative models. • Understand, apply and evaluate current approaches. • Understanding the technical underpinnings of unsupervised learning methods. • Evaluate and discuss new learning problems and unsupervised and self-supervised methods.			
Contents	Current issues, methods and datasets of unsupervised learning in image and text processing, including LSTMs, transformers, generative models.			
Applicability in the following courses of study	MA Computer Science			
Requirements for participation	Content: Basic knowledge of linear algebra and python is assumed. Formal: /			
Prerequisites for the award of credit points	Passed examination performance			
Literature	• Ian Goodfellow and Yoshua Bengio and Aaron Courville, Deep Learning, An MIT press book, 2016. • Attention and Augmented Recurrent Neural Networks, Chris Olah and Shan Carter. Distill, 2016 • Generating Sequence with Recurrent Neural Networks, A. Graves, ArXiV			
Other information				

Special features of the above-mentioned module description with regard to examination law when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA297			
Module title	Foreign Module Visual Computing I			
Responsible for the module	Prof. Dr. Roland Wismüller			
Teacher				
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Irregular			
Recommended semester	From 2			
Teaching language	country-specific			
Credit points	6			
SWS				
Presence study				
Self-study				
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
According to the host university				
Performance requirements	**Form**			**Duration/Scope**
Examination	According to the host university			
Study achievements	According to the host university			
Qualification goals	Students acquire further qualifications at a foreign university that enable them to understand and apply concepts, methods and tools in the field of visual computing that are not taught at the University of Siegen or not to the corresponding extent.			
Contents	The concrete contents of this module depend on the receiving university. They are to be determined prior to the stay abroad, whereby a significant overlapping of content with other modules is to be excluded. The subsequent recognition of the work performed abroad must be ensured in advance by means of a learning agreement.			
Applicability in the following courses of study				
Requirements for participation	---			
Prerequisites for the award of credit points	Passing the module at the host university. Learning Agreement for the recognition of achievements.			
Literature				
Other information				

No.	4INFMA298			
Module title	Foreign Module Visual Computing II			
Responsible for the module	Prof. Dr. Roland Wismüller			
Teacher				
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Irregular			
Recommended semester	From 2			
Teaching language	country-specific			
Credit points	6			
SWS				
Presence study				
Self-study				
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
According to the host university				
Performance requirements	**Form**			**Duration/Scope**
Examination	According to the host university			
Study achievements	According to the host university			
Qualification goals	Students acquire further qualifications at a foreign university that enable them to understand and apply concepts, methods and tools in the field of visual computing that are not taught at the University of Siegen or not to the corresponding extent.			
Contents	The concrete contents of this module depend on the receiving university. They are to be determined prior to the stay abroad, whereby a significant overlapping of content with other modules is to be excluded. The subsequent recognition of the work performed abroad must be ensured in advance by means of a learning agreement.			
Applicability in the following courses of study				
Requirements for participation	---			
Prerequisites for the award of credit points	Passing the module at the host university. Learning Agreement for the recognition of achievements.			
Literature				
Other information				

No.	4INFMA299			
Module title	Foreign Module Visual Computing III			
Responsible for the module	Prof. Dr. Roland Wismüller			
Teacher				
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Irregular			
Recommended semester	From 2			
Teaching language	country-specific			
Credit points	6			
SWS				
Presence study				
Self-study				
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
According to the host university				
Performance requirements	**Form**			**Duration/Scope**
Examination	According to the host university			
Study achievements	According to the host university			
Qualification goals	Students acquire further qualifications at a foreign university that enable them to understand and apply concepts, methods and tools in the field of visual computing that are not taught at the University of Siegen or not to the corresponding extent.			
Contents	The concrete contents of this module depend on the receiving university. They are to be determined prior to the stay abroad, whereby a significant overlapping of content with other modules is to be excluded. The subsequent recognition of the work performed abroad must be ensured in advance by means of a learning agreement.			
Applicability in the following courses of study				
Requirements for participation	---			
Prerequisites for the award of credit points	Passing the module at the host university. Learning Agreement for the recognition of achievements.			
Literature				
Other information				

No.	4INFMA300			
Module title	Algorithmics II			
Responsible for the module	Prof. Dr. Markus Lohrey			
Teacher	Prof. Dr. Markus Lohrey			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every summer semester			
Recommended semester	From 2			
Teaching language	German			
Credit points	6			
SWS	3			
Presence study	45 h			
Self-study	135 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Algorithmics II	60	2	
Exercise	Algorithmics II	30	1	
Performance requirements	**Form**	**Duration/Scope**		***Preliminary CP***
Examination	Oral examination	20-40 min.		4 CP
Study achievements	Successful completion of exercise or project tasks	1 task, approx. 10h		2 CP
Qualification goals	Students master advanced algorithmic techniques and data structures, and can apply these to concrete Apply problems.			
Contents	* Advanced data structures (e.g. union-find structures, Fibonacci heaps, compact data structures) Randomized algorithms * Parallel algorithms * Algorithms for data streams * Number theoretic algorithms			
Applicability in the following courses of study	MA Computer Science MA Mathematics			
Requirements for participation	Content: The module 4INFMA028 "Algorithmics I" should have been completed successfully. Formal: /			
Prerequisites for the award of credit points	Passed examination performance and passed course performance			
Literature				
Other information				

Examination-related special features of the above-mentioned module description when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**		
Oral supplementary examination possible	**Yes:**		**After each attempt:** / **After the last try:**
	No:	**X**	
Repeat examination for grade improvement possible	**Yes:**	**X***	
	No:		
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**		

No.	4INFMA301			
Module title	Model Checking			
Responsible for the module	Prof. Dr. Malte Lochau			
Teacher	Prof. Dr. Malte Lochau			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every winter semester			
Recommended semester	From 1			
Teaching language	German			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	model checking	60	3	
Exercise	model checking	30	1	
Performance requirements	**Form**			**Duration/Scope**
Examination	Oral examination or written test The form of the examination performance will be announced no later than four weeks after the start of the course.			30 min. 90 min.
Study achievements	---			
Qualification goals	Learning basic techniques and tools for the formal specification and verification of hardware and software systems. After completing the module, students should be able to select, evaluate and apply suitable techniques for concrete problems. In particular, they should learn how system properties can be expressed by formal languages such as temporal logics.			
Contents	- Process algebra and process equivalence - Linear Temporal Logic (LTL) and LTL Model Checking - Computation Tree Logic (CTL) and CTL model checking - Selected special topics			
Applicability in the following courses of study	BA Computer Science BA Dual Study Computer Science MA Computer Science			
Requirements for participation	Content: The modules 4INFBA001 "Discrete Mathematics", 4INFBA005 "Formal Languages and Automata" and 4INFBA006 "Computability and Logic" should have been successfully completed. Formal: /			
Prerequisites for the award of credit points	Passed examination performance and passed course performance			
Literature	- Lecture notes - Baier, Katoen: Principles of Model-Checking (MIT Press)			
Other information				

Examination-related special features of the above-mentioned module description when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA304			
Module title	Complexity Theory II			
Responsible for the module	Prof. Dr. Markus Lohrey			
Teacher	Prof. Dr. Markus Lohrey			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Irregular			
Recommended semester	From 2			
Teaching language	German/English			
Credit points	6			
SWS	3			
Presence study	45 h			
Self-study	135 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Complexity Theory II	60	2	
Exercise	Complexity Theory II	30	1	
Performance requirements	**Form**	**Duration/Scope**		***Preliminary CP***
Examination	Oral examination	20-40 min.		4 CP
Study achievements	Successful completion of exercise or project tasks	1 task, approx. 10h		2 CP
Qualification goals	Students understand advanced techniques for analyzing of the difficulty of algorithmic problems, and can apply to concrete problems.			
Contents	* Relativized complexity classes Randomized complexity classes * Interactive proof systems * Circuit complexity * Communication complexity			
Applicability in the following courses of study	MA Computer Science MA Mathematics			
Requirements for participation	Content: The module 4INFMA303 "Complexity Theory" should have been successfully completed. Formal: /			

Prerequisites for the award of credit points	Passed examination performance and passed course performance
Literature	
Other information	

Special features of the above-mentioned module description with regard to examination law when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA305			
Module title	Ubiquitous Computing			
Responsible for the module	Univ.-Prof. Dr. Kristof Van Laerhoven			
Teacher	Univ.-Prof. Dr. Kristof Van Laerhoven			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every semester			
Recommended semester	From 1			
Teaching language	German/English			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Ubiquitous Computing	60	2	
Exercise	Ubiquitous Computing	30	2	
Performance requirements	**Form**			**Duration/Scope**
Examination	Oral examination			40 min.
Study achievements	---			
Qualification goals	Students deepen their familiarity with the basic concepts in the field of ubiquitous computing and, after participation, are able to identify the new computer systems and apply relevant tools and terms from the fields of wearable computing and wireless sensor networks. In the exercises they learn to develop software and user interface for wearables and sensor nodes and to conduct user studies independently.			
Contents	The term "ubiquitous computing" refers to the ubiquity of tiny, interconnected wireless computers that can be built into or attached to any everyday object. Equipped with sensors, they can sense the object's environment or endow it with information processing and communication capabilities, giving objects a new, additional quality. On the one hand, the lecture gives an overview of the relevant concepts and basic technologies (e.g. wireless sensor networks, embedded systems, wearable computing), but on the other hand it also deals with more specific topics (e.g. context awareness, activity recognition, privacy and security issues, "Ubicomp" research methods).			
Applicability in the following courses of study	MA Computer Science			
Requirements for participation	---			
Prerequisites for the award of credit points	Passed examination performance			
Literature				
Other information				

Examination-related special features of the above-mentioned module description when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA307			
Module title	Advanced Programming in C++			
Responsible for the module	Univ.-Prof. Dr. Kristof Van Laerhoven			
Teacher				
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every summer semester			
Recommended semester	From 1			
Teaching language	English			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Advanced Programming in C++	60	2	
Exercise	Advanced Programming in C++	30	2	
Performance requirements	**Form**	**Duration/Scope**		***Preliminary CP***
Examination	Written examination	60 min.		4 CP
Study achievements	Successful completion of exercise or project tasks	approx. 12 tasks, approx. 45 h		2 CP
Qualification goals	Students are able to design and analyze software using object-oriented concepts. They are also able to apply central concepts of abstraction and modularization, implement solution ideas in programs and use a build system. Students further develop a basic understanding of compilers and linkers.			
Contents	Students learn advanced concepts and constructs of object-oriented programming languages as well as the basic principles such as classes, abstraction, modularization, encapsulation, inheritance, polymorphism, abstract methods, design patterns, and interfaces.			
Applicability in the following courses of study	Master Mechatronics MA Computer Science MA Mathematics			
Requirements for participation	Content: / Formal: Admission to the examination requires passing the course work in this module.			
Prerequisites for the award of credit points	Passed examination performance and passed study performance.			
Literature				
Other information				

Special features of the above-mentioned module description with regard to examination law when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA308			
Module title	Theoretical Computer Science			
Responsible for the module	Prof. Dr. Markus Lohrey			
Teacher	Prof. Dr. Markus Lohrey			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every winter semester			
Recommended semester	From 1			
Teaching language	German			
Credit points	6			
SWS	2			
Presence study	30 h			
Self-study	150 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Seminar	Theoretical Computer Science	30	2	
Performance requirements	**Form**			**Duration/Scope**
Examination	Seminar presentation			60-90 min.
Study achievements	---			
Qualification goals	Independent development and presentation of an advanced topic from theoretical computer science			
Contents	The seminar deals with current topics from theoretical computer science. Thereby, different focal points are set.			
Applicability in the following courses of study	MA Computer Science			
Requirements for participation	Content: The modules 4INFBA005 "Formal Languages and Automata" and 4INFBA006 "Computability and Logic" should have been successfully completed. Formal: /			
Prerequisites for the award of credit points	Passed examination performance			
Literature				
Other information				

Examination-related special features of the above-mentioned module description when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA310			
Module title	Recent Advances in Operating Systems and Distributed Systems			
Responsible for the module	Prof. Dr. Roland Wismüller			
Teacher	Prof. Dr. Roland Wismüller			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Irregular			
Recommended semester	From 1			
Teaching language	German/English			
Credit points	6			
SWS	2			
Presence study	30			
Self-study	150			
Workload	180			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Recent Advances in Operating Systems and Distributed Systems	60	2	
Performance requirements	**Form**	**Duration/Scope**		***Preliminary CP***
Examination	Oral examination	40 min.		4 CP
Study achievements	Active and regular participation	At least 80% of the dates		2 CP
Qualification goals	After completing this module, students will be able to understand selected *state-of-the-art* research papers in the field of operating systems, virtual machines, networks or distributed systems - if applicable on the basis of original publications - and to explain their main ideas and concepts in discussion with peers, to identify their merits and problems and to compare different approaches to solutions. In addition to technical competence, the ability to engage in scientific discussion is also to be deepened. Therefore, regular attendance on site is mandatory.			
Contents	This module presents recent advances in the areas of operating systems, virtual machines, networks or distributed systems, with a particular focus on recent research, new application areas and open questions in the above areas. Based on the basic prior knowledge from other modules, this module focuses specifically on the state of the art by using original publications to present the latest research results from leading international conferences and journals and actively discuss them with the participants*.			
Applicability in the following courses of study	MA Computer Science			
Requirements for participation	Content: Good prior knowledge of operating systems, computer networks and distributed systems is required. Formal: /			
Prerequisites for the award of credit points	Passed examination performance and passed study performance.			
Literature				
Other information				

Examination-related special features of the above-mentioned module description when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA312			
Module title	Recommender Systems			
Responsible for the module	Prof. Dr. Joeran Beel			
Teacher	Prof. Dr. Joeran Beel			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every summer semester			
Recommended semester	From 1			
Teaching language	English			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Recommender Systems	60	2	
Exercise	Recommender Systems	30	2	
Performance requirements	**Form**	**Duration/Scope**		***Preliminary CP***
Examination	Written examination	120 min.		4 CP
Study achievements	Successful completion of exercise or project tasks	1 task, approx. 40h		2 CP
Qualification goals	Students who successfully complete this module will understand the purpose of recommender systems; be able to make key design decisions and implement recommender algorithms and entire recommender systems; be able to conduct thorough evaluations; and be able to critically analyze evaluations conducted by others.			
Contents	Introduction to recommender systems with topics such as: - Goals and benefits of recommendation systems - Basic concepts (content-based filtering, collaborative filtering, ...) - Types of recommender systems (personalization vs. user modeling) - The recommendation ecosystem (stakeholders, software libraries, data sets, ...) Recommendation algorithms with topics such as: - Matrix factorization (SVD, SVD++, NMF, ...) - Neighbourhood algorithms (kNN and clustering) - Popularity based recommendations - Content-based methods (term weighting and text similarity) - Knowledge- & Graph-based recommendations (e.g. KGAT) - Hybrid algorithms Evaluation of recommender systems with topics such as: - Evaluation methods (offline vs. online evaluations) - Evaluation Metrics - Ground Truth and Baselines Further in-depth study with topics such as: - User interfaces for recommender systems - Context - Privacy - Multicriteria learning - Fairness, diversity, bias			
Applicability in the following courses of study	MA Computer Science			
Requirements for participation	Content: Basic knowledge of machine learning and/or information retrieval; basic knowledge of programming, ideally Python. Formal: /			
Prerequisites for the award of credit points	Passed examination performance and passed study performance.			

Literature	- Recommender Systems Handbook (2nd edt.; 2015). Francesco Ricci, Lior Rokach, Bracha Shapira - Recommender Systems: An Introduction (2010). Dietmar Jannach, Markus Zanker, Alexander Felfernig, and Gerhard Friedrich - Recommender Systems: The Textbook (2016). Charu C. Aggarwal
Other information	

Special features of the above-mentioned module description with regard to examination law when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

No.	4INFMA313			
Module title	Quantum Complexity Theory			
Responsible for the module	Prof. Dr. Markus Lohrey			
Teacher	Prof. Dr. Markus Lohrey			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every summer semester			
Recommended semester	From 2			
Teaching language	English			
Credit points	6			
SWS	3			
Presence study	45 h			
Self-study	135 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	*if necessary Workload/ CP*
Lecture	Quantum Complexity Theory	60	2	
Exercise	Quantum Complexity Theory	30	1	
Performance requirements	**Form**	**Duration/Scope**		*Preliminary CP*
Examination	Oral examination	20-40 min		4 CP
Study achievements	Successful completion of exercise or project tasks	1 task, approx. 10h		2 CP
Qualification goals	Students understand the function of quantum algorithms and know important quantum complexity classes and their relationships. Students are able to analyze the quantum complexity of algorithmic problems.			
Contents	- Introduction to Quantum Computing - Bounded error quantum polynomial time (BQP) - BQP complete problems - Quantum Merlin Arthur (QMA) - quantum Cook-Levin theorem - Quantum Interactive Protocols			
Applicability in the following courses of study	MA Computer Science MA Mathematics MA Quantum Science			
Requirements for participation	Content: The module 4INFMA303 "Complexity Theory I" should have been completed successfully. Formal: /			
Prerequisites for the award of credit points	Passed examination performance and passed course performance			
Literature				
Other information				

Special features of the above-mentioned module description with regard to examination law when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**		
Oral supplementary examination possible	**Yes:**		**After each attempt:** / **After the last try:**
	No:	**X**	
Repeat examination for grade improvement possible	**Yes:**	**X***	
	No:		
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**		

No.	4INFMA397			
Module title	Foreign Module Complex and Intelligent Software Systems I			
Responsible for the module	Prof. Dr. Roland Wismüller			
Teacher				
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Irregular			
Recommended semester	From 2			
Teaching language	country-specific			
Credit points	6			
SWS				
Presence study				
Self-study				
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
According to the host university				
Performance requirements	**Form**			**Duration/Scope**
Examination	According to the host university			
Study achievements	According to the host university			
Qualification goals	Students acquire further qualifications at a foreign university that enable them to understand and apply concepts, methods and tools in the field of Complex and intelligent Software Systems that are not taught at the University of Siegen or not taught to the corresponding extent.			
Contents	The concrete contents of this module depend on the receiving university. They are to be determined prior to the stay abroad, whereby a significant overlapping of content with other modules is to be excluded. The subsequent recognition of the work performed abroad must be ensured in advance by means of a learning agreement.			
Applicability in the following courses of study	MA Computer Science			
Requirements for participation	---			
Prerequisites for the award of credit points	Passing the module at the host university. Learning Agreement for the recognition of achievements.			
Literature				
Other information				

No.	4INFMA398			
Module title	Foreign Module Complex and Intelligent Software Systems II			
Responsible for the module	Prof. Dr. Roland Wismüller			
Teacher				
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Irregular			
Recommended semester	From 2			
Teaching language	country-specific			
Credit points	6			
SWS				
Presence study				
Self-study				
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
According to the host university				
Performance requirements	**Form**			**Duration/Scope**
Examination	According to the host university			
Study achievements	According to the host university			
Qualification goals	Students acquire further qualifications at a foreign university that enable them to understand and apply concepts, methods and tools in the field of Complex and intelligent Software Systems that are not taught at the University of Siegen or not taught to the corresponding extent.			
Contents	The concrete contents of this module depend on the receiving university. They are to be determined prior to the stay abroad, whereby a significant overlapping of content with other modules is to be excluded. The subsequent recognition of the work performed abroad must be ensured in advance by means of a learning agreement.			
Applicability in the following courses of study	MA Computer Science			
Requirements for participation	---			
Prerequisites for the award of credit points	Passing the module at the host university. Learning Agreement for the recognition of achievements.			
Literature				
Other information				

No.	4INFMA399			
Module title	Foreign Module Complex and Intelligent Software Systems III			
Responsible for the module	Prof. Dr. Roland Wismüller			
Teacher				
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Irregular			
Recommended semester	From 2			
Teaching language	country-specific			
Credit points	6			
SWS				
Presence study				
Self-study				
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
According to the host university				
Performance requirements	**Form**			**Duration/Scope**
Examination	According to the host university			
Study achievements	According to the host university			
Qualification goals	Students acquire further qualifications at a foreign university that enable them to understand and apply concepts, methods and tools in the field of Complex and intelligent Software Systems that are not taught at the University of Siegen or not taught to the corresponding extent.			
Contents	The concrete contents of this module depend on the receiving university. They are to be determined prior to the stay abroad, whereby a significant overlapping of content with other modules is to be excluded. The subsequent recognition of the work performed abroad must be ensured in advance by means of a learning agreement.			
Applicability in the following courses of study	MA Computer Science			
Requirements for participation	---			
Prerequisites for the award of credit points	Passing the module at the host university. Learning Agreement for the recognition of achievements.			
Literature				
Other information				

No.	4INFMA497			
Module title	Foreign Module Medical Informatics I			
Responsible for the module	Prof. Dr. Roland Wismüller			
Teacher				
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Irregular			
Recommended semester	From 2			
Teaching language	country-specific			
Credit points	6			
SWS				
Presence study				
Self-study				
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
According to the host university				
Performance requirements	**Form**			**Duration/Scope**
Examination	According to the host university			
Study achievements	According to the host university			
Qualification goals	Students acquire further qualifications at a foreign university that enable them to understand and apply concepts, methods and tools in the field of medical informatics that are not taught at the University of Siegen or not to the corresponding extent.			
Contents	The concrete contents of this module depend on the receiving university. They are to be determined prior to the stay abroad, whereby a significant overlapping of content with other modules is to be excluded. The subsequent recognition of the work performed abroad must be ensured in advance by means of a learning agreement.			
Applicability in the following courses of study	MA Computer Science			
Requirements for participation	---			
Prerequisites for the award of credit points	Passing the module at the host university. Learning Agreement for the recognition of achievements.			
Literature				
Other information				

No.	4INFMA498			
Module title	Foreign Module Medical Informatics II			
Responsible for the module	Prof. Dr. Roland Wismüller			
Teacher				
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Irregular			
Recommended semester	From 2			
Teaching language	country-specific			
Credit points	6			
SWS				
Presence study				
Self-study				
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
According to the host university				
Performance requirements	**Form**			**Duration/Scope**
Examination	According to the host university			
Study achievements	According to the host university			
Qualification goals	Students acquire further qualifications at a foreign university that enable them to understand and apply concepts, methods and tools in the field of medical informatics that are not taught at the University of Siegen or not to the corresponding extent.			
Contents	The concrete contents of this module depend on the receiving university. They are to be determined prior to the stay abroad, whereby a significant overlapping of content with other modules is to be excluded. The subsequent recognition of the work performed abroad must be ensured in advance by means of a learning agreement.			
Applicability in the following courses of study	MA Computer Science			
Requirements for participation	---			
Prerequisites for the award of credit points	Passing the module at the host university. Learning Agreement for the recognition of achievements.			
Literature				
Other information				

No.	4INFMA499			
Module title	Foreign Module Medical Informatics III			
Responsible for the module	Prof. Dr. Roland Wismüller			
Teacher				
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Irregular			
Recommended semester	From 2			
Teaching language	country-specific			
Credit points	6			
SWS				
Presence study				
Self-study				
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
According to the host university				
Performance requirements	**Form**			**Duration/Scope**
Examination	According to the host university			
Study achievements	According to the host university			
Qualification goals	Students acquire further qualifications at a foreign university that enable them to understand and apply concepts, methods and tools in the field of medical informatics that are not taught at the University of Siegen or not to the corresponding extent.			
Contents	The concrete contents of this module depend on the receiving university. They are to be determined prior to the stay abroad, whereby a significant overlapping of content with other modules is to be excluded. The subsequent recognition of the work performed abroad must be ensured in advance by means of a learning agreement.			
Applicability in the following courses of study	MA Computer Science			
Requirements for participation	---			
Prerequisites for the award of credit points	Passing the module at the host university. Learning Agreement for the recognition of achievements.			
Literature				
Other information				

No.	4INFMA800LA			
Module title	Informatics Education - Project			
Responsible for the module	Dr. Steffen Jaschke			
Teacher	Dr. Steffen Jaschke			
Faculty	IV			
Compulsory/elective	Compulsory			
Module duration	1 semester			
Frequency of supply	Every winter semester			
Recommended semester	1			
Teaching language	German			
Credit points	12			
SWS	4			
Presence study	60 h			
Self-study	300 h			
Workload	360 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Project work	Informatics Education - Project	8	4	
Performance requirements	**Form**	**Duration/Scope**		***Preliminary CP***
Examination	Project work (individual work)	15 min, 6000 words		8 CP
Study achievements	Project reports	15 minutes		4 CP
Qualification goals	Students: - have a sound knowledge of the characteristics of pupils that can promote or inhibit learning success in computer science lessons (diagnosis) and know how to use this knowledge to design differentiated learning environments (support). - can identify and analyze problems from the field of school and computer science and develop a draft solution - can plan and implement projects independently - can develop software modules and/or hardware components in teams - can present results in a target group-oriented manner and discuss them professionally The requirements for the written and oral project presentation and documentation as well as the project reports will be communicated at the beginning of the course. The module Informatics Education - Project contains achievements totalling 2 credit points on inclusion-oriented issues. The module Computer Science Education - Project contains subject-specific didactic achievements totalling 4 credit points.			
Contents	- Problems of school practice in computer science teaching - Development of tools for informatics education - Hardware and software components depending on the project task			
Applicability in the following courses of study	MA Computer Science in the teaching profession for HRSGe MA Computer Science in the teaching profession for GymGe MA Computer Science in the teaching profession for BK-A			
Requirements for participation	---			
Prerequisites for the award of credit points	Passed examination performance and passed study performance.			
Literature				
Other information				

No.	4INFMA801LA			
Module title	Didactics of Computer Science II			
Responsible for the module	Dr. Steffen Jaschke			
Teacher	Stefan Schramm			
Faculty	IV			
Compulsory/elective	Compulsory			
Module duration	1 semester			
Frequency of supply	Every summer semester			
Recommended semester	2			
Teaching language	German			
Credit points	9			
SWS	4			
Presence study	60 h			
Self-study	210 h			
Workload	270 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Seminar	Preparatory seminar	30	2	90 h/3 CP
Seminar	Advanced seminar	30	2	90h /3 CP
Performance requirements	**Form**	**Duration/Scope**		***Preliminary CP***
Examination	Homework	10000 words		5 CP
Study achievements	Preparatory Seminar: Seminar presentation with elaboration In-depth seminar: Seminar presentation with elaboration	15 minutes 2500 words15 minutes 2500 words		2 CP 2 CP
• Qualification goals	Preparatory seminar: The students: - can relate scientific contents of the subject computer science to situations and processes of school practice. - plan computer science lessons based on theory in different breadths and depths in a well-founded and addressee-oriented manner. - can establish links between their specialist knowledge and school informatics, design teaching concepts and media, also for heterogeneous learning groups, evaluate content, follow recent informatics research in overviews and introduce new topics into lessons in an appropriate way for the target group, - are able to adapt the presentation and explanation of informatics contents methodically, if necessary in a target-differentiated way and in coordination, also with other pedagogical specialists, to the needs of a heterogeneous group of pupils. In particular, they use a reflected, consistent selection of informatics terminology. - can analyze the basics and processes of subject-specific and interdisciplinary learning in computer science, taking into account subject-specific learning difficulties and support options, and organise exemplary interdisciplinary learning processes. - know the basics of subject- and requirement-appropriate performance diagnosis and performance assessment in computer science lessons and can apply these in school-related fields of activity in a practice-oriented manner Advanced seminar: The students: - can analyze relevant subject-specific content in terms of its educational effectiveness and didactic aspects.			

	- know relevant results of computer didactics, learning psychology and social science research on the design of teaching and learning environments, can relate them to each other and apply them to exemplary planning and design of computer science lessons. - can apply the educational content of informatics contents and methods, bring informatics contents into a teaching context and think them through as well as consider interdisciplinary perspectives. - are able to review and reflect on teaching concepts and to further develop teaching approaches and methods, taking into account new professional knowledge. - can use subject didactic concepts and empirical findings of informatics-related teaching-learning research and diagnostic tools to analyze individual ways of thinking and ideas of students depending on their personal prerequisites, previous experiences and abilities, to motivate students for learning informatics as well as to promote and assess individual learning progress. The module Didactics of Computer Science II contains a total of 2 credit points on inclusion-oriented issues. The module Didactics of Computer Science II contains subject-specific didactic achievements totalling 7 credit points.
Contents	Preparatory Seminar: - Curricular framework of teaching - Planning, organisation and implementation of computer science lessons - Formulation of lesson topics - Formulation and taxonomisation of learning objectives - Phasing of lessons - Design of lesson plans - Initial lessons in computer science - Sources, media and materials for subject teaching - Individual focus (elective topics) In-depth seminar: - Current scientific and didactic issues in the subject area - Practical references
Applicability in the following courses of study	MA Computer Science in the teaching profession for HRSGe MA Computer Science in the teaching profession for GymGe MA Computer Science in the teaching profession for BK-A
Requirements for participation	---
Prerequisites for the award of credit points	Passed examination performance and passed study performance.
Literature	
Other information	

No.	4INFMA802LA			
Module title	Master Thesis Computer Science in Teaching			
Responsible for the module	Dr. Steffen Jaschke			
Teacher	Professors and staff of the Department ETI			
Faculty	IV			
Compulsory/elective	cf. Article 4 § 8			
Module duration	1 semester			
Frequency of supply	Every semester			
Recommended semester	4			
Teaching language	German			
Credit points	20			
SWS	0			
Presence study	0 h			
Self-study	600 h			
Workload	600 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Performance requirements	**Form**			**Duration/Scope**
Examination	Master Thesis			maximum 60 Pages without Attachments
Study achievements	---			
Qualification goals	Students can • independently conduct a literature search on a given topic using literature databases and other sources, • read, understand, and evaluate original English-language literature in relation to the assignment, • Analyze, evaluate, plan and/or implement more extensive software and/or hardware systems,			
Contents	In the final thesis, a challenging problem of the field of study must be worked on independently according to scientific methods and presented orally and in writing within a specified period of time.			
Applicability in the following courses of study	MA Informatik im Lehramt für HRSGeMA Informatik im Lehramt für GymGeMA Informatik im Lehramt für BK-A			
Requirements for participation	cf. Article 4 § 11			
Prerequisites for the award of credit points	Passed examination performance			
Literature				
Other information				

Annex 6 to Article 5: Module descriptions of modules offered for export only

No.	4INFMAEX900			
Module title	Computer Science			
Responsible for the module	Univ.-Prof. Dr. Kristof Van Laerhoven			
Teacher	Univ.-Prof. Dr. Kristof Van Laerhoven; Alexander Hoelzemann			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	2 semesters			
Frequency of supply	winter semester			
Recommended semester				
Teaching language	German			
Credit points	9			
SWS	7			
Presence study	105			
Self-study	165			
Workload	270			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	ubiquitous computing	60	2	
Exercise	ubiquitous computing	30	2	
Lecture	Programming in C	60	2	
Exercise	Programming in C	30	1	
Performance requirements	**Form**	**Duration/ Scope**		***Preliminary CP***
Examination	Overall examination performance consisting of two examination elements (weighting 50% each): oral exam on ubiquitous computing Written exam on Programming in C.	 40 min. 60 min.		7 CP
Study achievements	Successful completion of exercises and project tasks on Programming in C.	approx. 5 tasks, approx. 30 h.		2 CP
Qualification goals	Students deepen their familiarity with the basic concepts in the field of ubiquitous computing and, after participation, are able to identify the new computer systems and apply relevant tools and terms from the fields of wearable computing and wireless sensor networks. In the exercises they learn to develop software and user interface for wearables and sensor nodes and to conduct user studies independently. Furthermore, students will learn and understand the basic concepts of the C programming language and will be able to solve, apply and analyze smaller programming tasks in C independently using the concepts presented.			
Contents	ubiquitous computing The term "ubiquitous computing" refers to the ubiquity of tiny, interconnected wireless computers that can be built into or attached to any everyday object. Equipped with sensors, they can sense the object's environment or endow it with information processing and communication capabilities, giving objects a new, additional quality. This may even be accompanied by a paradigm shift in computer science applications: away from the PC and the computer as a tool, towards "invisible computing". On the one hand, the lecture gives an overview of the relevant concepts and basic technologies (e.g. wireless sensor networks, embedded systems, wearable computing), but on the other hand it also deals with more specific topics (e.g. context awareness, activity recognition, privacy and security issues, "Ubicomp" research methods). Programming in C			

	The course teaches the use of the practical programming language C and focuses on the programming of embedded systems.
Applicability in the following courses of study	MA Psychology
Requirements for participation	---
Prerequisites for the award of credit points	Passed examination performance and passed study performance.
Literature	
Other information	

Examination-related special features of the above-mentioned module description when used in several degree programs

Repeatability of the examination performance(s) (number / scheduling)	**Repeat dates for failed examinations are offered in the following semester.**			
Oral supplementary examination possible	**Yes:**		**After each attempt:**	
			After the last try:	
	No:	**X**		
Repeat examination for grade improvement possible	**Yes:**	**X***		
	No:			
Special features	***Only applies to students who are enrolled in a degree program whose FPO contains a regulation for free attempts.**			

Appendix 7: Module descriptions of the modules imported from other degree programs
The modules in Annex 7, which contain the module descriptions imported from the subject Computer Science, cease to apply when the subject examination regulations to which the respective module is assigned come into force.

No.	4INFMA900			
Module title	Telematics - Multimedia			
Responsible for the module	Dr. Kai Hahn			
Teacher	Dr. Kai Hahn			
Faculty	Fak. V			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every winter semester			
Recommended semester	From 1			
Teaching language	German/English			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture		60	2	
Seminar		30	2	
Performance requirements	**Form**			**Duration/Scope**
Examination	Oral examination			20 - 40 min.
Study achievements				
Qualification goals	After attending the Telematics-Multimedia course, students will be able to: • describe and explain basic multimedia technologies and data formats • to show the psychological and physiological prerequisites for multimedia perception • classify multimedia processes and combine them with each other in • Relate • to be able to deduce the status-quo of multimedia procedures from their history • understand new multimedia data formats and assess their significance • apply acquired knowledge to new multimedia techniques • carry out and assess technology impact assessments in an application-specific manner			
Contents	The course contents first deal with the physiological and psychological abilities of humans and the resulting boundary conditions for the coding of multimedia data. At the beginning there is a summary of the communication basics. The historical foundations of multimedia data include text, font, font. Fundamentals of vision and color are preparation for raster image data formats. The human ability to hear and psychoacoustics form the audio fundamentals. Based on this, audio data formats are discussed. The classical (analogue) video technology is the preliminary consideration for the digital video compression methods. MPEG, multimedia encryption standards, as well as the transmission of media content with digital broadband audio/video transmission methods such as DVB. Media law and media economics shed light on the social and economic implications of telematics in the multimedia sector. The contents are worked out both in the lecture and in the exercises.			
Applicability in the following courses of study	MA Computer Science			

Requirements for participation	Content: Basic knowledge of network technology (computer networks) and digital technology (switching systems, switching networks). Formal: /
Prerequisites for the award of credit points	Passing the examination performance
Literature	
Other information	

No.	4INFMA901			
Module title	Telematics - Technologies and Applications			
Responsible for the module	Dr. Kai Hahn			
Teacher	Dr. Kai Hahn			
Faculty	Fak. V			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every summer semester			
Recommended semester	From 1			
Teaching language	German/English			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture		60	2	
Seminar		30	2	
Performance requirements	**Form**			**Duration/Scope**
Examination	Oral examination			20 - 40 min.
Study achievements				
Qualification goals	After attending the Telematics Technology and Applications course, students will be able to: • describe and explain the basic technologies and applications of telematics • Classify and correlate technology areas such as wired or wireless communications or application areas such as e-commerce. • be able to derive the status quo of technologies and applications from its history • to recognize telematics technologies also in new fields of application • apply acquired knowledge to new telematics applications • carry out and assess technology impact assessments in an application-specific manner			

Contents	In the course Telematics Technology and Applications, detailed knowledge of basic telematics technology and its applications is taught. The specialist knowledge acquired in the other courses (computer networks, digital technology) is used and expanded for telematics. Particular emphasis is placed on imparting knowledge equally via the lecture and the exercises that accompany it. Practical applications are discussed in the exercises. Telematics technologies include: • Modelling of telecommunication systems • Internet, mobile communications, satellite services • Public telecommunications networks, standardisation procedures • Telematics hardware, medical sensor technology • Physiological and psychological basics Applications based on this include: • Electronic markets/marketing, technical infrastructures, m-commerce, payment systems, security, legal framework, logistics - RFID in retail, • Multimedia learning systems, • Traffic telematics, MIV applications, technologies (GPS, DAB ...) • Tele-surgery, hospital information systems, electronic patient card • Multimedia electronic patient record, data cards in health care, network-based services • Telemedicine in medical care, public health information for citizens and patients • Cost/benefit ratios for doctors and patients, technological framework conditions, legal framework conditions The contents are acquired through lectures and exercises.
Applicability in the following courses of study	MA Computer Science
Requirements for participation	Content: Basic knowledge of network technology (computer networks) and digital technology (switching systems, switching networks). Formal: /
Prerequisites for the award of credit points	Passing the examination performance
Literature	
Other information	

No.	5DBHSBAEX02			
Module title	Internship Clinic			
Responsible for the module	Prof. Dr. Rainer Brück			
Teacher				
Faculty	V			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	annual			
Recommended semester	From 1			
Teaching language	German/English			
Credit points	3			
SWS	1			
Presence study	15 h			
Self-study	75 h			
Workload	90 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Internship	Internship clinic	-	1	
Performance requirements	**Form**			**Duration/Scope**
Examination	-			
Study achievements	Two course credits: In the "Internship Clinic" (certificate) and participation in the feedback workshop. The feedback workshop is a mandatory event of about 1 hour in which the experiences of the interns and trainees are discussed.			60 min.
Qualification goals	The students - should be able to name and, if necessary, evaluate differences and similarities between theoretically imparted knowledge within the university and practically experienced execution within the clinics. - know the structural daily routine of different professions (doctor, assistant, nurse, etc.) and are able to distinguish between the associated areas of responsibility using the example of their internship experience. - gain a basic understanding of the economic framework conditions that are necessary for the operation of a clinic. - can describe the structural and organisational processes in a clinic using a case of illness as an example. - name key figures and parameters of the economic consideration of a clinic and its documentation process in the clinic IT - develop a differentiated picture of everyday life in German clinics by comparing different internships (or their presentations by fellow students).			
Contents	During the internship (2 weeks), the students gain insights into the content-related and structural everyday life of a clinic. In the clinical internship, students accompany doctors, nurses and assistants in order to link their previously acquired theoretical knowledge with practical experience. During the internships, it is particularly desirable to convey to the students the perspective and requirements of a modern clinic, which in turn is the basis for the nature of organizational structures, work processes and chains of command.			
Applicability in the following courses of study	MA Computer Science			
Requirements for participation	Content: / Formal: /			

Prerequisites for the award of credit points	Passed study achievements
Literature	
Other information	

No.	4ETMA257			
Module title	Communications and Information Security II			
Responsible for the module	Prof. Dr. Ch. Ruland			
Teacher	Ruland			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every summer semester			
Recommended semester	from 1st semester			
Teaching language	German or English			
Credit points	6			
SWS	4			
Presence study	60			
Self-study	120			
Workload	180			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture		20	2	
Practical Exercise		20	2	
Performance requirements	**Form**			**Duration/Scope**
Examination	Oral examination			20-40 min.
Study achievements				
Qualification goals	The students are able to form cryptographic protocols from cryptographic mechanisms and to integrate the cryptographic mechanisms into communication protocols and distributed applications. They know the sublayer principle, with which security services and mechanisms can be embedded in communication systems. You will get an overview of standardized security protocols in LAN, wireless communication, IPSEC, TCP/IP, internet applications, smart grid, smart city and industry 4.0. You will be familiar with VPN techniques and firewall design. You will be animated to critically analyze security systems. Aspects of security management, the connection between security and safety (functional safety) and an overview of security standards round off the topic.			
Contents	• cryptographic protocols for data integrity, authentication, key management, non-repudiation • Security modules, smart cards • Certificates, Public Key Infrastructures • Common Criteria, Evaluation and Certification • Integration of cryptographic methods in communication systems (physical layer, LAN, mobile radio, WLAN, Bluetooth, ...) • Internet Security, SSL/TLS, SRTP,... • Packet filters and firewalls • Information security for eCommerce and industrial applications (banking, automotive, smart grid, smart metering, smart city, IoT, IIoT, Industry 4.0 (OPC UA) • Anonymous communication • Security Management • Overview of standards in the field of IT security			
Applicability in the following courses of study	• Elective module Master Computer Science, • Compulsory elective module Master Electrical Engineering Communication Technology study model			
Requirements for participation	Communications and Information Security I I			
Prerequisites for the award of credit points	• Passing the examination performance • successful participation in the practical exercise			

Literature	• C. Eckert: IT-Sicherheit, Oldenbourg Verlag, • N. Pohlmann:
Other information	

No.	4ETMA201			
Module title	Communications Engineering I			
Responsible for the module	Prof. Dr. O. Loffeld			
Teacher	Prof. Dr. O. Loffeld, Dr. H. Nies			
Faculty	IV			
Compulsory/elective	Compulsory			
Module duration	1 semester			
Frequency of supply	Every winter semester			
Recommended semester	1			
Teaching language	English (Exercise: German by arrangement)			
Credit points	6			
SWS	4			
Presence study	60			
Self-study	120			
Workload	Attendance study: 60 h, self-study: 90 h, Exam preparation: 30 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
	Lecture	15	2	
	Exercise	15	2	
Performance requirements	**Form**			**Duration/Scope**
Examination	Written examination			2
Study achievements				
Qualification goals	The student is able to understand and apply linear systems theory to the development of processing algorithms in one and multi-dimensional signal processing (coding theory, image processing, image analysis). Through this, students improve their abilities to grasp real problems and complex relationships through model building, to abstract them and to make them accessible to mathematical solution. Likewise, problems with a high level of abstraction can be grasped and solved. Furthermore, the students improve their logical thinking as well as their strategy for further knowledge acquisition.			

Contents	Provision of mathematical and communication basics and skills Knowledge: • Concept of the signal • periodic and non-periodic signals • linear and nonlinear systems • time-variant and time-invariant systems • Scanning in time and frequency domain • Convolution and correlation • Modulation method Skills: • Description of signals in time and frequency domain • Description of linear time-invariant systems in the time and frequency domain • Understanding of the relationships between continuous-time and discrete-time signals and systems on the basis of sampling theory • Understanding the relationships between periodic and non-periodic signals by sampling in the frequency domain • Measurement of the similarity of signals by minimizing a quadratic distance measure (correlation, correlation by convolution) • Matched Filter Reception • Low-pass and band-pass systems and signals (understanding and forms of description)
Applicability in the following courses of study	Master's program "Electrical Engineering Master's program "Computer Science
Requirements for participation	• Fundamentals of Communications Engineering (Bachelor course, strongly recommended) • Fundamentals of Signal and Systems Theory (undergraduate course, strongly recommended), • Content: Signals and signal characteristics, periodic signals and their analysis, linear systems, convolution integral and Fourier transform, signal transmission via linear systems
Prerequisites for the award of credit points	Passing the examination performance
Literature	• Lüke, Ohm, Signal Transmission, Springer Textbook • Puente, Leaon, Kiencke, Jäkel, Signals and Systems, Olderbourg Verlag Munich • Lecture notes as pdf in German • Recording of the slides and annotations as pdf-file • Recording and archiving of the lecture as a video stream • Archiving of all documents with the e-learning system Moodle, interactive tests in the Moodle system, Java applets for self-study. The same applies to the seminar. Lecture notes, web content are updated semester by semester and referenced in the lecture.
Other information	

No.	4ETMA251			
Module title	Stochastic Models			
Responsible for the module	Prof. Dr. O. Loffeld			
Teacher	Prof. Dr. O. Loffeld, research associate. Staff			
Faculty	IV			
Compulsory/elective	Elective "Communication Technology" course variant			
Module duration	1 semester			
Frequency of supply	Every winter semester			
Recommended semester	2			
Teaching language	English			
Credit points	6			
SWS	4			
Presence study	60			
Self-study	120			
Workload				
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
	Lecture	8	2	
	Exercise	8	2	
Performance requirements	**Form**			**Duration/Scope**
Examination	Oral examination			40 minutes
Study achievements				
Qualification goals	The student is given the skills, given a stochastic observation problem of a static unknown state, the optimal estimation solution is sought to determine the unknown state from the noisy observations.			
Contents	Provision of mathematical and estimation theoretical basics and skills Knowledge: • Dynamic linear models and state space description • Probability and random variables Skills: • Modeling of linear dynamical systems in state space • Solution of state space differential equations • Formulation of discrete time equivalent systems • Optimal estimation for static stochastic problems • Bayesian estimation • Conditional mean estimation • Maximum likelihood estimation • Recursive minimum variance estimation • Static Kalman filter			
Applicability in the following courses of study	Master's program "Electrical Engineering Master's program "Computer Science			
Requirements for participation	• Communications Engineering I (strongly recommended), Fundamentals of Control Engineering (GRT) Content: Fundamentals of modern control engineering, state space representation, fundamentals of communication engineering and signal theory			
Prerequisites for the award of credit points	Passing the examination performance			

Literature	• O. Loffeld, Estimation Theory I, Oldenbourg Verlag München, • P.S. Maybeck, Stochastic Models Estimation and Control I, II, Academic Press, • B.D.O.. Anderson, J.B. More, Optimal Filtering, Prentice Hall. • Recording and archiving of the lecture as a video stream • Recording of the slides and annotations as pdf-file • Archiving of all documents with the e-learning system Moodle, interactive tests in the Moodle system, Java applets for self-study. The same applies to the seminar. Lecture notes, web content are updated semester by semester and referenced in the lecture.
Other information	

No.	4ETMA250			
Module title	Estimation Theory / Compressed Sensing			
Responsible for the module	Prof. Dr. O. Loffeld			
Teacher	Prof. Dr. O. Loffeld, Dr. M. Heredia Conde			
Faculty	IV			
Compulsory/elective	Elective "Communication Technology" course variant			
Module duration	1 semester			
Frequency of supply	Every summer semester			
Recommended semester	2			
Teaching language	English			
Credit points	6			
SWS	4			
Presence study	60			
Self-study	120			
Workload				
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
	Lecture	8	2	
	Exercise	8	2	
Performance requirements	**Form**			**Duration/Scope**
Examination	Oral examination			40 minutes
Study achievements				
Qualification goals	The student will gain the skills to find the optimal estimation solution in stochastic observation problems of a dynamically changing unknown state to determine the unknown state from the noisy observations.			

Contents	In this lecture, we dive into the groundbreaking theory of Compressed (or Compressive) Sensing (CS), which links the sampling effort to the amount of information present in the signal, which does not necessarily depend on its maximum occurring frequency. In this way, discrete signals of very high resolutions, such as images, can be accurately reconstructed from a set of measurements whose sampling rates are often well below those suggested by the Nyquist rate. Provision of mathematical and estimation theoretical basics and skills Knowledge: • Stochastic processes • linear dynamic models with stochastic input • optimal estimation principles for dynamic problems • Basics of Compressive Sensing • Sparse Reconstruction - Algorithms and Methods Skills: Modelling of dynamic stochastic problems and estimation of time-variable unknown states with optimal recursive estimation methods, possibly including sparsity constraints Stochastic processes: Stochastic processes in continuous and discrete time, description of stochastic processes, classes of stochastic processes, processes with independent increments, Brownian motion, continuity and differentiability of stochastic processes, white noise, modeling with additive noise processes, integration of stochastic processes, Wieners stochastic integration, Markov processes, Gauss-Markov processes, linear models with white Gaussian distributed noise Estimation approaches for stochastic processes: Kalman filters and different formulations, different approaches to derive Kalman filters. Applications: State space modeling and optimal estimation using examples.
Applicability in the following courses of study	Master's program "Electrical Engineering Master's program "Computer Science
Requirements for participation	• Stochastic Models (strongly recommended) Content: Linear dynamic and stochastic models, probability and random variables (in depth)
Prerequisites for the award of credit points	Passing the examination performance
Literature	• O. Loffeld, Estimation Theory II, Oldenbourg Verlag München, • P.S. Maybeck, Stochastic Models Estimation and Control I, II, Academic Press, • B.D.O.. Anderson, J.B. More, Optimal Filtering, Prentice Hall. • Recording and archiving of the lecture as a video stream • Recording of the slides and annotations as pdf-file • Archiving of all documents with the e-learning system Moodle, interactive tests in the Moodle system, Java applets for self-study. The same applies to the seminar. Lecture notes, web content are updated semester by semester and referenced in the lecture.
Other information	

No.	4ETMA160			
Module title	Reliability of Technical Systems			
Responsible for the module	Prof. Dr. Frank Gronwald			
Teacher	Prof. Dr. Frank Gronwald			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every summer semester			
Recommended semester	2			
Teaching language	German/English			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	120 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture		20	2	90 h / 3 CP
Exercise		20	2	90 h / 3 CP
Performance requirements	**Form**			**Duration/Scope**
Examination	Oral examination			20 - 40 min
Study achievements				
Qualification goals	After successful completion of the module, students possess the following competences: - Understanding of essential parameters of reliability, availability and safety - Application of probability theory to reliability problems - Planning and evaluation of the reliability of devices and systems - Selection of suitable methods to increase reliability - Understanding of statistical methods and statistical processes for modelling and demonstrating reliability - Structuring and presentation of independent and newly acquired knowledge			
Contents	The module "Reliability of Technical Systems" teaches the basics of understanding, planning and proving the reliability of technical systems. Presented are: - Fundamentals of probability theory - Reliability and safety parameters - Statistical life distributions and their characteristics - Reliability and safety management - Reliability analysis of simple system structures - Boolean modelling and fault tree analysis - Markovian modelling and graph theory - Test and inspection planning for statistical quality control			
Applicability in the following courses of study	Master's program "Electrical Engineering Master's program "Computer Science			
Requirements for participation	none			
Prerequisites for the award of credit points	Passing the examination performance			

Literature	- A. Birolini: "Reliability Engineering: Theory and Practice", 8th ed, (Springer, 2017). - A. Meyna and B. Pauli: "Zuverlässigkeitstechnik: Quantitative Bewertungsverfahren", 2nd edition, (Hanser, 2010). - M.A. Carlton and J.L. Devore, "Probability with Applications in Engineering, Science, and Technology", (Springer, 2014). - R. Storm: "Probability theory, mathematical statistics and statistical quality control", 12th edition, (Hanser, 2007).
Other information	

No.	4ETMA159			
Module title	Assembly and Connection Technology			
Responsible for the module	Prof. Dr.-Ing. Elmar Griese			
Teacher	Dr.-Ing. Bernd Klose (Lecture); Dr.-Ing. Thomas Kühler (Exercise)			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every summer semester			
Recommended semester	From 1st semester			
Teaching language	German			
Credit points	6			
SWS	4			
Presence study	60 h			
Self-study	60 h self-study, 60 h exam preparation			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
	Lecture	16	2	
	Exercise	16	2	
Performance requirements	**Form**			**Duration/Scope**
Examination	Oral			40 min
Study achievements	None			
Qualification goals	Content competence • Be able to recognize and distinguish between different assembly technologies for electronic assemblies • be able to explain the electrical properties of the printed circuit board • be able to name and explain the production processes of printed circuit boards • be able to explain the manufacturing processes of different microvia techniques • be able to explain test methods for printed circuit boards and assemblies • be able to explain the electronic assembly from an ecological point of view Methodological competence • Be able to implement your own CAD-based printed circuit board designs and build printed circuit board assemblies. • Be able to design simple high current and HDI designs. • be able to develop and apply test strategies for assembled and unassembled printed circuit boards Assessment competence • Be able to evaluate design tools in terms of their strengths, weaknesses and costs. • Be able to evaluate assembly techniques in terms of their advantages and disadvantages. • be able to evaluate microvia techniques in relation to their economic and ecological properties • Be able to evaluate test methods and procedures in terms of performance and cost			

Contents	The lecture provides an overview of common assembly techniques of electronic assemblies and delves into selected topics, such as microchip handling, packaging techniques, PCB layout, high current and HDI design, PCB techniques, embedded active and passive components, multichip modules, test, ecology and technical developments of the future. In the exercise, each student independently designs and realizes a printed circuit board assembly.
Applicability in the following courses of study	Master's program "Electrical Engineering Master's program "Computer Science
Requirements for participation	No formal prerequisites, but basic electrical engineering and possibly materials engineering knowledge is recommended.
Prerequisites for the award of credit points	Design, manufacture and documentation of a printed circuit board assembly; passing the test
Literature	• Hanke, Hans-Joachim: Baugruppentechnologie der Elektronik. Printed circuit boards. Verlag Technik, Berlin. 1994 • Hanke, Hans-Joachim: Baugruppentechnologie der Elektronik. Hybrid carrier. Verlag Technik, Berlin. 1994 • Herrmann, Günther et al: Handbuch der Leiterplattentechnik. Volumes 1-3. Eugen G. Leuze Verlag, 1993 • Jillek, Werner; Keller, Gustl: Handbuch der Leiterplattentechnik. Volume 4. Eugen G. Leuze Verlag, 2003 • Klose, Bernd: Chip-first systems and packages. Shaker Verlag, Aachen. 2000 • Scheel, Wolfgang: Baugruppentechnologie der Elektronik. Assembly. Verlag Technik, Berlin. 1999
Other information	

No.	4ETMA304			
Module title	Digital IC Design			
Responsible for the module	Choice			
Teacher	Choice			
Faculty	IV			
Compulsory/elective	Compulsory			
Module duration	1 semester			
Frequency of supply	Every summer semester			
Recommended semester	1			
Teaching language	English			
Credit points	6			
SWS	6			
Presence study	90			
Self-study	90			
Workload	180			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Digital IC Design		2	
Exercise	Digital IC Design		2	
Internship	Digital IC Design	10	2	
Performance requirements	**Form**			**Duration/Scope**
Examination	Oral examination			
Study achievements	Successful participation in the internship			
Qualification goals	Students should first be able to describe the design process for digital integrated circuits. In the practical course, students should apply the knowledge they have acquired in order to independently implement given tasks.			
Contents	Design process for digital integrated circuits: The design process as a higher-level approach. Design steps - logic design - synthesis - simulation - verification - test methods			
Applicability in the following courses of study	Master Electrical Engineering, Master Computer Science			
Requirements for participation				
Prerequisites for the award of credit points	Successful participation in the internship and passing of the exam			
Literature				
Other information				

No.	4ETMA355			
Module title	Microsystem Fabrication & Test			
Responsible for the module	Choice			
Teacher	Choice			
Faculty	IV			
Compulsory/elective				
Module duration	1 semester			
Frequency of supply	Annual winter semester			
Recommended semester	3			
Teaching language	English			
Credit points	6			
SWS	5			
Presence study	75 h			
Self-study	105 h			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lecture	Microsystem Fabrication & Test		3	
Exercise	Microsystem Fabrication & Test	15	2	
Performance requirements	**Form**			**Duration/Scope**
Examination	Oral examination			
Study achievements				
Qualification goals	Students should be able to grasp and evaluate the complexity of the topics of manufacturing and testing digital circuits.			
Contents	The contents are divided into two main areas. Fabrication: Starting with the raw material, the basic steps are taught as well as the construction of a circuit through the repeated application of the fabrication steps. The topic of testing includes - the basic test model - Procedure for the determination of the test vectors, - Measures to improve testability - testing standards - Physical methods for performing tests			
Applicability in the following courses of study	Master Computer Science, Master Electrical Engineering			
Requirements for participation				
Prerequisites for the award of credit points	Oral examination			
Literature				
Other information				

No.	4ETMA152			
Module title	Process Automation			
Responsible for the module	Prof. Schröder			
Teacher	Prof. Schröder and scientific Staff			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Lecture/ Exercise/ Practical course: Every summer semester			
Recommended semester	1./2.			
Teaching language	German			
Credit points	6			
SWS	4			
Presence study	100			
Self-study	80			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lectures, exercises			2	
Lectures, exercises			1	
Practical Lab Course		4	1	
Performance requirements	**Form**			**Duration/Scope**
Examination	Oral examination			1/2 h
Study achievements	Participation in the practical lab course			
Qualification goals	Students achieve the following learning objective with the module described here as part of the Master Electrical Engineering degree program: They obtain the necessary specialist competences in the field of process automation at Master level and they acquire methodological skills in their application. Students will be able to • understand, assess and apply for themselves the way in which automation technology is currently implemented in hardware and software in the field of machines and systems • define digital and analog interfaces to the process, to the operator and to intelligent external devices and use them sensibly • classify production machines and plants into categories and select suitable automation concepts for them • correctly assess the possibilities and limits of various automation concepts. In the laboratory practical course, students experiment with typical tasks from the field of automation technology. • You analyze typical processes in order to select, create, parameterise and commission suitable hardware and software. • You will be able to select and apply suitable procedures for testing and verifying automation solutions. The following learning methodology is used for this purpose: Specialist knowledge is taught and explained in lectures, the examination of it is stimulated and supported by exercise scenarios, and methodical application competence is conveyed by practical examples.			

Contents	Programming and project planning with SPS devices: • Programming languages according to IEC 61131-3 (KOP, FBS, AWL, structured text) • Handling of different types of variables • Cyclic, time-controlled and alarm-controlled processing of software • Logic controls and sequence controls Interface to the process: • Hardware for Boolean signals • Hardware for communication with displacement and angle encoders • Absolute and incremental measuring methods • Analogue to digital conversion and vice versa • Voltage-to-current and current-to-voltage conversion • Electromagnetic compatibility • Processing of digital and analog input signals • Simple digital filters and controls Hydraulics as an actuator in automated processes: • Fundamentals of fluid power • Transducers and actuators of the automation system • Typical application scenarios • Proportional valves Laboratory experiments on different focal points from the above-mentioned topics are to be carried out.
Applicability in the following courses of study	Master Electrical Engineering, Master Computer Science
Requirements for participation	No formal requirements.
Prerequisites for the award of credit points	Passing of the study achievements and the examination performance
Literature	• Lecture notes (available in Moodle) • Günter Wellenreuther/ Dieter Zastrow: Automation with PLC, Springer-Verlag • E. Habiger: Handbuch elektromagnetische Verträglichkeit, Verlag Technik • Rudolf Lauber / Peter Göhner: Process Automation 1 and 2 , Springer Verlag
Other information	Prerequisites for the content: Knowledge imparted in the fundamentals of electrical engineering and in physics.

No.	4ETMA151			
Module title	Industrial Communication			
Responsible for the module	Prof. Schröder			
Teacher	Prof. Schröder and scientific Staff			
Faculty	IV			
Compulsory/elective	Elective			
Module duration	1 semester			
Frequency of supply	Every summer semester			
Recommended semester	2.			
Teaching language	German			
Credit points	6			
SWS	4			
Presence study	100			
Self-study	80			
Workload	180 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	***if necessary Workload/ CP***
Lectures, exercises			2	
Lectures, exercises			1	
Internship		4	1	
Performance requirements	**Form**			**Duration/Scope**
Examination	Oral examination			1/2 h
Study achievements	Participation in the internship			
Qualification goals	Students achieve the following learning objective with the module described here as part of the Master Electrical Engineering degree program: They obtain the necessary specialist competences in the field of digital communication in automation technology at Master level and they acquire methodological skills in their application. Students will be able to • Understand, evaluate and apply for themselves the way automation devices currently communicate at their interfaces to the process, to the HMI and to other digital devices. • define digital interfaces to the process, to the operator and to intelligent third-party devices and use them sensibly • to correctly assess the possibilities and limitations of different procedures. In the laboratory practical course, students experiment with typical communication systems for automation technology. • You will analyze the effort required for the commissioning and performance of typical standard solutions and will thus be enabled to select, create, parameterise and commission suitable hardware and software. • You will be able to select and apply suitable procedures for testing and verifying communication systems. The following learning methodology is used for this purpose: Specialist knowledge is taught and explained in lectures, the examination of it is stimulated and supported by exercise scenarios, and methodical application competence is conveyed by practical examples.			

Contents	Basics and fieldbuses: • 7-layer model of communication • Serial point-to-point connections • Transmission method (layer 1) • Access procedure • Selected fieldbus systems (Profibus, Interbus-S, CAN, Sercos, AS-i, IO-Link) Industrial Ethernet: • Ethernet basics • Basics TCP/IP and UDP • Differences between office and industrial environments • Communication structures (client/server, publisher/subscriber, producer/consumer) • Network Security • Real-time capability • IEEE 1588 time synchronization • Selected Industrial Ethernet systems (EtherCAT, EtherNet / IP, Ethernet PowerLink, Modbus TCP, Sercos III, Profinet) • OPC UA / TSN Laboratory experiments on different focal points from the above-mentioned topics are to be carried out.
Applicability in the following courses of study	Master Electrical Engineering, Master Computer Science
Requirements for participation	No formal requirements.
Prerequisites for the award of credit points	Passing of the study achievements and the examination performance
Literature	• Lecture notes (available in Moodle) • M. Popp: Das Profinet IO-Buch, Hüthig-Verlag • Mahnke, Leitner, Damm; OPC Unified Architecture, Springer Verlag • Klasen/ Oestreich (Eds.): Industrial Communication with Fieldbus and Ethernet, VDE-Verlag
Other information	Prerequisites for the content: Knowledge imparted in the fundamentals of electrical engineering and in physics.

No.	5DMTMA02			
Module title	Medical Technology Specialisation			
Responsible for the module	Prof. Dr. Rainer Brück			
Teacher	Prof. Dr. Rainer Brück, Dr. Steffen Büchner			
Faculty	Faculty V - Faculty of Life Sciences			
Compulsory/elective	Compulsory			
Module duration	1 semester			
Frequency of supply	every winter semester			
Recommended semester	1			
Teaching language	German/English			
Credit points	9			
SWS	6			
Presence study	90 h			
Self-study	180 h			
Workload	270 h			
Teaching and learning form	**Events/module elements, if applicable**	**Group size**	**SWS**	*if necessary Workload/ CP*
Lecture	Specialisation in medical devices	25	2	
Internship	medical internship	25	4	
Performance requirements	**Form**			**Duration/Scope**
Examination	Oral examination			20-40 minutes
Study achievements	Regular and active participation in the internship			
Qualification goals	Students will be able to: – explain in-depth knowledge of the mechanisms and physical, chemical as well as biological fundamentals of special procedures in medical technology. – explain the process from the medical-technical result extraction and its documentation up to the presentation of the interpreted or sat data and point out dangers and chances. – make a statement about the testability of devices under development and explain constraints. Within the internship the students work in small teams. They will learn team decision-making (FOR-DEC), crew resource management (CRM), supervision, communication and goal-oriented work.			
Contents	Content: – Technical therapy devices and approaches – Laser systems – Blood Purification – Medical radiotherapy – Medical information processing – Requirements and conception of laboratories – Mechanical loading of bones, joints and soft tissues and their interaction with endoprostheses – Material fatigue – Walking aids, rehabilitation, implants and biomaterials – Testing of medical devices in artificial environments			
Applicability in the following courses of study	Digital Medical Technology (FPO-M 2019)			
Requirements for participation	None			
Prerequisites for the award of credit points	Passed examination performance and passed course performance			
Literature				
Other information				