

UNIVERSITÄT ZU LÜBECK

Module Guide for the Study Path

Master Computer Science 2012

Version from 11. April 2025





specialization field medical informatics

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computer science

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advanced curriculum intelligent embedded systems

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advanced curriculum signal and image processing

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advanced curriculum enterprise IT

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advanced curriculum imaging systems

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specialization field IT security and safety

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Model Checking (CS4138, ModelCheck)	103
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	CS4240 - Syntactical Pattern Recognition (SyntakMust)					
Duration: Turnus of offer: Credit points: Max. group size:						
1 Semester	not available anymore	4	99			
Course of study, spec	ific field and term:					
Master Comput	er Science 2012 (optional subject), speciali	zation field medical informatics, 3rd	d semester			
Classes and lectures:		Workload:				
 Syntactical Pattern Recognition (lecture, 2 SWS) Syntactical Pattern Recognition (exercise, 1 SWS) 		 55 Hours private stu 45 Hours in-classroot 20 Hours exam prepared 	 55 Hours private studies and exercises 45 Hours in-classroom work 20 Hours exam preparation 			
Contents of teaching	:					
 Transform image Grammar types Stochastical lin Method for cale Generalization Parsing for stoc Examples: Corce 	 Syntactical description of visual objects of structures, such as chromosome types Transform image data in the symbolical desciption Grammar types for structure description: beginning with indexed and attributed grammars to tree- or web-grammars Stochastical linear grammars, theoretical properties such as consistency Method for calculating probabilities of control samples out of generated text pattern Generalization of stochastical grammars Parsing for stochastic or feature grammars Examples: Coronary vessels with concrete LR (1) grammar for the classification of stenosis 					
Qualification-goals/C • Understanding • Understanding • Understanding	 Qualification-goals/Competencies: Understanding of the use of syntactical methods for symbolic object descriptions and classification tasks Understanding of the distinction to the most used statistical approaches to pattern recognition Understanding of the usage of grammatical algorithms for classification syntactically described objects 					
Grading through: • Written or oral	exam as announced by the examiner					
Responsible for this r	nodule:					
• Prof. Dr. rer. na	t. habil. Heinz Handels					
Teacher:	lied Information					
Institute of Med						
Prof. Dr. rer. na	t. habil. Heinz Handels					
Literature: • K. S. Fu: Syntac • H. Ney: Maschin • M. R. Ogiela, R.	 Literature: K. S. Fu: Syntactic Pattern Recognition and - Englewood Cliffs, NJ: Prentice Hall H. Ney: Maschinelle Sprachverarbeitung: Der statistische - Informatik Spektrum 26:6, 94-102 M. R. Ogiela, R. Tadeusiewicz: Syntactic reasoning and pattern recognition for - Artificial Intelligence in Medicine 26, 145-159 					
Language: • offered only in	German					



	CS4270-KP04, CS4270 - N	ledical Robotics (M	edRob)
Duration:	Turnus of offer:		Credit points:
1 Semester	each summer semester		4
Course of study, specific fi Master MES 2020 (op Master Biophysics 20 Master MES 2014 (op Master Biomedical Ei Master Computer Sc Master Computer Sc Master Computer Sc Master Computer Sc Master Computer Sc	eld and term: ptional subject), computer science / electric ptional subject), computer science / electric ptional subject), computer science / electric ngineering (optional subject), Interdisciplin ience 2012 (optional subject), advanced cu ience 2012 (optional subject), advanced cu lvanced curriculum), imaging systems, sign ience 2012 (compulsory), specialization fiel ience 2012 (optional subject), specialization	al engineering, Arbitrary er al engineering, Arbitrary ary modules, 2nd semes rriculum imaging system rriculum signal and imag al and image processing d robotics and automati n field medical informati	y semester y semester ster hs, 2nd or 3rd semester ge processing, 2nd or 3rd semester g, 2nd semester on, 2nd semester cs, 2nd or 3rd semester
Classes and lectures:		Workload:	
 Medical Robotics (le Medical Robotics (ex 	cture, 2 SWS) ercise, 1 SWS)	 55 Hours priva 45 Hours in-cla 20 Hours example 	nte studies assroom work n preparation
Contents of teaching:			
 Students are able to They are able to app Students are able to Students are able to Grading through: 	explain the concepts of forward and inversily methods of medical robot systems and t transfer methods of motion learning to sin modify templates for dynamic calculations	e kinematics for the exa simple practical applic practical problems. in order to create the ca	Imples of 3-joint and 6-joint robots. cations. alculations for their own constructions.
Oral examination			
Responsible for this modu • Prof. DrIng. Achim S Teacher: • Institute for Robotics • Prof. DrIng. Achim S	le: Schweikard s and Cognitive Systems Schweikard		
Literature: • JC. Latombe: Robo • J.J. Craig: Introductic • : lecture notes (400 p	t Motion Planning - Dordrecht: Kluwer 199 on to Robotics - Pearson Prentice Hall 2002 pages full text)	0	
Language: • offered only in Engli:	sh		
Notes: Admission requiremen - None	ts for taking the module:		
Admission requiremen - Successful completio	ts for participation in module examination n of exercise assignments as specified at th	(s): e beginning of the seme	ester
Module Exam(s): - CS4270-L1: Medical R	obotics, written exam, 90min, 100% of the	module grade	



CS4280 - Business Information Systems (BetrInfosy)					
Duration:	Turnus of offer:	(Credit points:		
1 Semester	not available anymore		4		
Course of study, specific field and term: • Master Computer Science 2012 (opt • Master Computer Science 2012 (opt	ional subject), advanced cu ional subject), specializatioi	rriculum enterprise IT, 2nd o n field medical informatics, 3	r 3rd semester rd semester		
Classes and lectures: • Business Information Systems (lectu • Business Information Systems (exerc	re, 2 SWS) cise, 1 SWS)	Workload: • 55 Hours private st • 45 Hours in-classro • 20 Hours exam pre	udies and exercises from work eparation		
Contents of teaching: • • • • • Qualification-goals/Competencies: • •					
• Grading through: • Written or oral exam as announced	by the examiner				
Responsible for this module: • Prof. Dr. rer. nat. habil. Josef Ingener Teacher: • Institute of Medical Informatics • Institute of Telematics • Prof. Dr. Rüdiger Lohmann	f				
Literature: • : • : • : • : Language: • offered only in German					



CS4310 - I	nformation Models a	nd Ontologies in Medicine (IOM)
Duration:	Turnus of offer:	Credit points:
1 Semester	each summer semester	4
Course of study, specific field and term: • Master Computer Science 2012 (con	npulsory), specialization fie	ld medical informatics, 2nd semester
 Classes and lectures: Information Models and Ontologies in Medicine (lecture, 2 SWS) Information Models and Ontologies in Medicine (exercise, 1 SWS) 		 Workload: 55 Hours private studies and exercises 45 Hours in-classroom work 20 Hours exam preparation
 Contents of teaching: Medical documentation and commu Structured (database), semi-structure Medical linguistics: unstructured tex HL7 Version 3 Syntactical standards for messages a Reporting) Semantical standards, terminologies Standards for the integration of known 	unication red (XML documents) and u cts and documents, including I s / ontologies (ICD-10, OPS, weledge bases (Guidelines,	Instructured documentation (free text) HL7 CDA (Clinical Document Architecture), DICOM SR (Structured SNOMED-CT, LOINC, UMLS) Literature-DB) in clinical applications
Qualification-goals/Competencies: Understanding of typical application Knowledge of methods and tools for Knowledge of current standards of the stand	ns and challenges in r standardized documenta different structure levels: da	tion and communication in healthcare ata models, documents / messages terminology
Grading through: • Written or oral exam as announced	by the examiner	
Responsible for this module: • Prof. Dr. rer. nat. habil. Josef Ingener Teacher: • Institute of Medical Informatics • Prof. Dr. rer. nat. habil. Heinz Hande • Prof. Dr. rer. nat. habil. Josef Ingener	f Is f	
 Literature: T. Lehmann: Handbuch der Medizin J. Ingenerf, R. Linder, S. J. Pöppl: Info im Diplom-Studiengang Informatik. P. Haas: Medizinische Informationss J. H. van Bemmel: Handbook of Medizinische 	ischen Informatik - Münche ormatik im Gesundheitswes Hagen: Fern-Universität Ha ysteme und Elektronische H lical Informatics - Houten/E	יח: Hanser 2004 en - Skript zur Pflicht-Lehreinheit im Nebenfach Medizinische Informatik agen 2002 Krankenakten - Berlin: Springer 2005 Diegem: Bohn Stafleu Van Loghum 2002
Language: • offered only in German		





Γ

CS43	320 - Methods and Sys	tems in Health Care	(VSG)
Duration:	Turnus of offer:		Credit points:
1 Semester	each winter semester		4
Course of study, specific field and term: • Master Computer Science 2012 (com	npulsory), specialization field	d medical informatics, 1st s	emester
 Classes and lectures: Methods and Systems in Health Care (lecture, 2 SWS) Methods and Systems in Health Care (exercise, 1 SWS) 		 Workload: 55 Hours private studies and exercises 45 Hours in-classroom work 20 Hours exam preparation 	
 Contents of teaching: Fundamentals and motivation of an increasing integrated care in the health care system. Approaches for a standardization of a wide variety of electronic data exchange formats in health care. Asynchronous versus synchronous communication methods of distributed software systems Distributed, heterogeneous hospital-information-system: communication server to ensure a consistent data management Method and system components of health telematic infrastructures from an international perspective. 			
 Qualification-goals/Competencies: Understanding of problems and solutions in the implementation of distributed application systems in health care Knowledge of the essential components of a health telematics infrastructure Knowledge of major middleware architectures and techniques in health care with focus on the issue of data privacy 			
Grading through: • Written or oral exam as announced b	by the examiner		
 Responsible for this module: Prof. Dr. rer. nat. habil. Josef Ingener Prof. Dr. rer. nat. habil. Heinz Handel Teacher: Institute of Medical Informatics Prof. Dr. rer. nat. habil. Heinz Handel Prof. Dr. rer. nat. habil. Josef Ingener 	f s s f		
 Literature: B. Blobel: Analysis, Design and Imple Press 2002 J. Ingenerf, S. J. Pöppl: Gesundheitste Nebenfach Medizinische Informatik P. Haas: Gesundheitstelematik - Grunden 1990 	ementation for Secure and le elematik: Datenmodelle und im Diplom-Studiengang Inf ndlagen, Anwendungen, Po	nteroperable Distributed H d notwendige Infrastruktur ormatik. Hagen: Fern-Unive tenziale - Berlin: Springer 2	lealth Information Systems - Amsterdam: IOS ren - Skript zur Wahlpflicht-Lehreinheit im ersität Hagen 2003 2006
Language: • offered only in German			



СЅ4330-КР04, С	S4330 - Image Analysis and Vi	sualization in Diagnos	tics and Therapy (BAVIS)
Duration:	Turnus of offer:	Credit points:	Max. group size:
1 Semester	not available anymore	4	99
Course of study, specific field Master MES 2020 (optior Master MES 2014 (optior Master MES 2011 (advan Master CLS 2010 (option Master Computer Science	and term: nal subject), medical engineering scienc nal subject), medical engineering scienc ced curriculum), imaging systems, sign al suject), computer science, Arbitrary s e 2012 (compulsory), specialization fiel	e, Arbitrary semester e, 1st or 2nd semester al and image processing, 2nd emester d medical informatics, 2nd so	d semester emester
Classes and lectures:		Workload:	
 Image Analysis and Visualization Systems in Diagnostics and Therapy (lecture, 2 SWS) Image Analysis and Visualization Systems in Diagnostics and Therapy (exercise, 1 SWS) 		 55 Hours private st 45 Hours in-classro 20 Hours exam pre 	udies and exercises om work paration
Contents of teaching:			
 Methods and algorithms for the analysis and visualization of medical images including current research activities in the field of medical image computing. The following methods and algorithms are explained: Data driven segmentation of multispectral image data Random Decision Forests for the segmentation of medical image data Convolutional Neural Networks and Deep Learning in Medical Image Processing live wire segmentation segmentation with active contour models and deformable models level set segmentation statistical shape models image registration atlas-based segmentation and multi atlas segmentation using non-linear registration visualization techniques in medicine direct volume rendering, ray tracing, ray casting haptic 3D interactions in virtual bodies virtual reality techniques in medical applications 			
 Qualification-goals/Competen The students can classify of their properties and so They are able to explain Decision Forests, and to They know different app to explain the optimizati They are able to assess ti measures and regulariza They are familiar with me fusion approaches. They can distinguish diff and select and apply the They can explain different 	reies: a dvanced methods for medical image elect them problem-specifically for a co advanced methods of cluster analysis a characterize them based on their proper roaches to model-based segmentation on strategies and algorithms used here he properties of different non-linear im tion terms for a specific registration pro- ethods of multi-atlas segmentation and rerent medical visualization techniques, m depending on a concrete application the haptic interaction techniques and ca	analysis and visualization, experience application. and classification, especially verties. , can describe the different rest age registration methods an oblem. d can explain and exemplarily classify them according to t n problem. n classify different systems for	xplain them, characterize them on the basis with Support Vector Machines and Random nodel assumptions made here and are able id to select and parameterize similarity y apply the properties of different label heir specific advantages and disadvantages or VR simulation in medicine.
Written or oral exam as a	nnounced by the examiner		
Requires: • Medical Image Computir • Medical Image Computir	ng (CS3310-KP09) ng (CS3310-KP08, CS3310SJ14)		



Responsible for this module:	
Prof. Dr. rer. nat. habil. Heinz Handels	
Teacher:	
Institute of Medical Informatics	
Prof. Dr. rer. nat. habil. Heinz Handels	
Literature:	
H. Handels: Medizinische Bildverarbeitung - 2. Auflage, Vieweg u. Teubner 2009	
• T. Lehmann: Handbuch der Medizinischen Informatik - München: Hanser 2005	
 M. Sonka, V. Hlavac, R. Boyle: Image Processing, Analysis and Machine - 2nd edition. Pacific Grove: PWS Publishing 1998 B. Preim, D. Bartz: Visualization in Medicine - Elsevier, 2007 	
Language:	
offered only in German	
Notes:	
Notes: This module is no longer offered and will be replaced by the new module "CS4332-KP04 Model and AI based image processing in medicine".	
Notes: This module is no longer offered and will be replaced by the new module "CS4332-KP04 Model and AI based image processing in medicine". Prerequisites for attending the module:	
Notes: This module is no longer offered and will be replaced by the new module "CS4332-KP04 Model and AI based image processing in medicine". Prerequisites for attending the module: - None (The competences of the required modules are required for this module, but the modules are not a prerequisite for admission.)	
Notes: This module is no longer offered and will be replaced by the new module "CS4332-KP04 Model and AI based image processing in medicine". Prerequisites for attending the module: - None (The competences of the required modules are required for this module, but the modules are not a prerequisite for admission.) Prerequisites for the exam:	

completed and positively assessed before the initial examination.



CS4340 - Health Economy (GOEK)				
Duration: Turnus of offer: Credit points:		Credit points:		
1 Semester	1 Semester every summer semester		4	
 Course of study, specific field and term: Bachelor MES 2011 (compulsory), medicine, 5th semester Master Computer Science 2012 (compulsory), specialization field medical informatics, 1st semester 				
Classes and lectures:		Workload:		
 Health Economy (lecture, 2 SWS) Health Economy (exercise, 1 SWS) 		 55 Hours private 45 Hours in-classi 20 Hours exam private 	studies and exercises room work reparation	
Contents of teaching: PART 1: FUNDAMENTALS OF HEALTH Relevance and objectives of econom Forms of study Cost types Effectiveness measures Decision analyses Sensitivity analyses Evaluation of digital health applicati PART 2: DECISION ANALYTICAL MOD Decision trees Markov cohort models Microsimulations Mathematical models (differential ec Qualification-goals/Competencies: PART 1: FUNDAMENTALS OF HEALTH They know the different forms of he They can explain types of costs and They are familiar with different meas They know the steps of decision ana They can assess the suitability of dat analyses by changing assumptions a They can apply the knowledge they products and procedures. PART 2: DECISION ANALYTICAL MOD They know the strengths and limitat application examples. They can use the above-mentioned m They can use the above-mentioned m You can use the above-mentioned m You can calibrate epidemiological m	HECONOMIC EVALUATIONS ic evaluation in the contex ons DELING quation models) for the spre- HECONOMIC EVALUATIONS alth economics studies and measurement approaches f sures of effectiveness and c ectiveness analyses for med lysis and can carry out corr a sources for health econor ind data sources. have acquired to analyze a DELING ions of different model typ rkov models, microsimulati ogram them in suitable sof nodel types to carry out hea ivariate, multivariate and p g analyses. odels using epidemiologica	ead of infectious diseases can differentiate between for determining them in he an discuss the advantages ical interventions / health p esponding analyses on the mic studies, reflect on paral nd critically assess specific es and are able to make an ons and epidemiological m ftware. alth economic evaluations. robabilistic sensitivity analy al data.	them. Palth economic studies. and disadvantages of each. programs. basis of evaluation results. meter assumptions and carry out sensitivity studies on the cost-effectiveness of medical appropriate model selection for specific nodels (based on differential equations) for yses (Monte Carlo simulations) in suitable	
Responsible for this module:				
Prof. Dr. Alexander Kuhlmann				
Teacher:				
Institute for Social Medicine and Epidemiology				



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 Prof. Dr. Katrin Balzer Prof. Dr. Alexander Kuhlmann 	
_iterature:	Lite
• :	
•:	
•:	
• :	
-anguage: • offered only in German	Lang
Notes:	Note
Prerequisites for attending the module: - None	
Prerequisites for the exam: - Preliminary examinations can be determined at the beginning of the semester. If preliminary work has been defined, it must have been completed and positively assessed before the initial examination.	



(CS4350 - Knowledge Bases and Expert Systems in Medicine (WibaExpMed)					
Duration:	Turnus of offer:	Credit points:	Max. group size:			
1 Semester	irregularly	4	99			
Course of study, specifi • Master Computer	c field and term: Science 2012 (optional subject), specializatior	field medical informatics, 2r	d or 3rd semester			
 Classes and lectures: Knowledge Bases and Expert Systems in Medicine (e-learning, 2 SWS) Knowledge Bases and Expert Systems in Medicine (exercise, 1 SWS) 		 Workload: 60 Hours private studies and exercises 40 Hours work on project 20 Hours exam preparation 				
Contents of teaching: Logische Grundla Datenbanken un spezielle Repräse die Verarbeitung Ansätze der Entso medizinisches Kn	 Contents of teaching: Logische Grundlagen der symbolischen Datenbanken und spezielle Repräsentationsformate und die Verarbeitung unsicheren medizinischen Ansätze der Entscheidungsanalyse im klinischen medizinisches Knowledge Engineering sowie die 					
Qualification-goals/Con • Kenntnis der rele • Problembewusst • Befähigung zur S • Befähigung zur A	Qualification-goals/Competencies: • Kenntnis der relevanten methodischen Grundlagen • Problembewusstsein und Analysefähigkeit zu den • Befähigung zur Systemanalyse und zum Systementwurf • Befähigung zur Auswahl und Anwendung geeigneter					
Grading through: • successful addres	sing of the project goals					
Responsible for this mo Prof. Dr. rer. nat. I Teacher: Institute of Medic Prof. Dr. Dr. Klaus	Responsible for this module: Prof. Dr. rer. nat. habil. Heinz Handels Teacher: Institute of Medical Informatics Prof. Dr. Dr. Klaus Spitzer 					
Literature: • : • : • :						
Language: • offered only in Ge	erman					



	CS5151 - Telen	nedicine (TeleMed)		
Duration:	Turnus of offer:		Credit points:	
1 Semester	not available anymore		4	
Course of study, specific field and a • Master Computer Science 207 • Master Computer Science 207	term: 12 (optional subject), specializati 12 (optional subject), specializati	on field media informatics, on field medical informatic	2nd or 3rd semester s, 3rd semester	
Classes and lectures:		Workload:		
Telemedicine (lecture, 2 SWS) Telemedicine (exercise, 1 SWS) Telemedicine		 60 Hours privat 45 Hours in-cla 15 Hours exam 	e studies ssroom work preparation	
Contents of teaching: Introduction Computer and multimedia Media Compression Methods Quality of Service Group Communication Specific Telemedical Applicat	ions			
Qualification-goals/Competencies: • Understanding of the problem • Knowledge of basic compress • Estimation of multimedia cap • Knowledge of the most relev	ms of digital media and especial sion methods for digital media a pabilities of traditional networks ant telemedicine applications no	ly their transmission over N nd their respective applica and knowledge of opportu owadays and assessment of	letworks. tions. nities for improvement. f specific application situations.	
Grading through: • Oral examination				
Responsible for this module: • Prof. Dr. rer. nat. habil. Heinz • Prof. Dr. Stefan Fischer	Handels			
Teacher:Institute of Medical InformationInstitute of Telematics	cs			
• Prof. Dr. rer. nat. habil. Heinz	Handels			
Literature: • R. Steinmetz: Multimedia Tec • T. Lehmann: Handbuch der M	hnologie - 3. Auflage. Berlin: Spr Iedizinischen Informatik - 2. Aufl	inger 2001 age. München: Hanser 200	4	_
Language: • offered only in German				



MA2214-KP04, MA2214 - Clinical Studies (KlinStud)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each winter semester		4	
 Course of study, specific field and term: Bachelor CLS 2023 (compulsory), mathematics, 3rd or 5th semester Master Nutritional Medicine 2023 (compulsory), medical computer science, 1st semester Bachelor Medical Informatics 2019 (optional subject), medical computer science, 4th to 6th semester Bachelor CLS 2016 (compulsory), mathematics, 3rd or 5th semester Master Nutritional Medicine 2019 (compulsory), medical computer science, 1st semester Bachelor CLS 2016 (compulsory), mathematics, 3rd or 5th semester Master Nutritional Medicine 2019 (compulsory), medical computer science, 1st semester Bachelor Medical Informatics 2014 (optional subject), medical computer science, 5th or 6th semester Master Computer Science 2012 (optional subject), specialization field medical informatics, 3rd semester Bachelor Medical Informatics 2011 (optional subject), medical computer science, 4th to 6th semester Bachelor Medical Informatics 2011 (optional subject), medical computer science, 4th to 6th semester Bachelor Medical Informatics 2011 (optional subject), medical computer science, 4th to 6th semester Bachelor MES 2011 (optional subject), life sciences, 3rd or 5th semester Bachelor MES 2011 (optional subject), life sciences, 3rd or 5th semester 				
Classes and lectures:		Workload:		
 Clinical Studies (lecture, 2 SWS) Clinical Studies (exercise, 1 SWS) 		 60 Hours private studies and exercises 45 Hours in-classroom work 15 Hours exam preparation 		
Contents of teaching: 15 Hours exam preparation 15 Hours exam preparation Contents of teaching: Definition of a clinical study according to the German Drug Law, classification of clinical studies, clinical development Basic principles of clinical trials and measures against bias Regulations and study documents Development of a clinical study, especially a study protocol Contents of a study protocol Contents of a study protocol Contents of a study protocol Eurther topics like Special study designs Advanced statistical analyses Report and publication Systematic overview and meta-analyses Data management and system validation Professional fields in clinical studies (study statistics, data management, monitoring, quality management, pharmacovigilance, project management) Cualification-goals/Competencies: Students can describe the regulatory framework of clinical trials with drugs. They can describe the main areas of activity in the fields of study statistics, data management, monitoring, information technology and quality assurance. They can explain the basic principles of clinical trials and measures to achieve these basic principles. They can perform case number planning for simple clinical studies. Students can assign studies and their key points to the stages of clinical development. They can explain different study designs. 				
Grading through:				
• portiolio exam				
Requires: • Biostatistics 1 (MA1600-KP04, MA160	00, MA1600-MML)			
Responsible for this module:				



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

Teacher:

- Institute of Medical Biometry and Statistics
- PD Dr. rer. pol. Reinhard Vonthein
- Prof. Dr. rer. biol. hum. Inke König

Literature:

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

Language:

• German and English skills required

Notes:

Admission requirements for taking the module:

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

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

Module exam(s):

- MA2214-L1: Clinical Studies, portfolio exam, 100 % of module grade, with a total of 200 points, distributed as follows:

+ 145 points for project work with documentation and presentations

+ 55 points for 5 short term papers

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

documentation and presentation.



MA2600-KP04, MA2600 - Biostatistics 2 (BioStat2)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each summer semester		4	
Course of study, specific field and term: Master Medical Informatics 2019 (o Master Biophysics 2019 (optional st Master Medical Informatics 2014 (o Master Computer Science 2012 (op Master Computer Science 2012 (op Master Computer Science 2012 (op Bachelor CLS 2010 (compulsory), m	ptional subject), Medical Data ubject), Elective, 2nd semester ptional subject), ehealth / info tional subject), specialization tional subject), specialization tional subject), advanced curr nathematics, 4th semester	Science / Artificial Intell r omatics, 1st or 2nd seme field medical informatics field bioinformatics, 2nd iculum stochastics, 2nd s	igence, 1st or 2nd semester ster s, 3rd semester or 3rd semester semester	
Classes and lectures:Workload:• Biostatistics 2 (lecture, 2 SWS)• 45 Hours in-classroom work• Biostatistics 2 (exercise, 1 SWS)• 35 Hours private studies• 25 Hours programming• 15 Hours exam preparation			sroom work e studies amming preparation	
 • 15 Hours programming • 15 Hours exam preparation Contents of teaching: • Knowledge of model assumptions and mathematical foundation of model assumptions for the linear model • Knowledge of possible sources of errors in the modelling • Competence in independent analysis of a study using the linear model • Competence in correctly interpreting study results • Competence in parameter interpretation and regression diagnostics • Knowledge of model assumptions and mathematical foundation of the generalized linear model • Competence in parameter interpretation and regression diagnostics • Knowledge of model assumptions and mathematical foundation of the generalized linear model • Competence in the independent analysis of a simple study with a dichotomous outcome • Competence in correctly interpreting study results of a study with a dichotomous outcome • Competence in correctly interpreting study results of a study with a dichotomous outcome Qualification-goals/Competencies: • The students are able to enumerate and explain the assumptions of the classical linear model. • The students are able to elscribe typical applications of the classical linear model. • The students are able to claculate the estimators (point and interval estimators, residual) in the linear model. • The students are able to calculate the estimators (point and interval estimators, residual) in the linear model. • The students are able to interpret the results of studies, where a linear, a logistic or a Cox regression model was applied. • The students are able to draw and interpret Kaplan-Meier curves. • The students are able to perform data transformations. Grading through:				
Is requisite for: • Multivariate Statistics (MA4944) • Interdisciplinary Seminar (MA3300)				
Requires: • Biostatistics 1 (MA1600-KP04, MA1	600, MA1600-MML)			
 Responsible for this module: Prof. Dr. rer. biol. hum. Inke König Teacher: Institute of Medical Biometry and S Prof. Dr. rer. biol. hum. Inke König Dr. rer. hum. biol. Markus Scheinha 	itatistics rdt			



Literature:

Ludwig Fahrmeir, Thomas Kneib, Stefan Lang: Regression: Modelle, Methoden und Anwendungen - ISBN-13 9783540339328

Dobson, Annette J & Barnett, Adrian: An Introduction to Generalized Linear Models, 3rd ed. - Chapman & Hall/CRC: Boca Raton (FL), 2008

Language:

• offered only in German

Notes:

Prerequisites for attending the module:

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

Prerequisites for the exam:

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



MA3200-KP04, MA3200 - Genetic Epidemiology 1 (GenEpi1)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each winter semester		4	
 Course of study, specific field and term: Bachelor CLS 2023 (compulsory), mathematics, 3rd or 5th semester Master Medical Informatics 2019 (optional subject), Medical Data Science / Artificial Intelligence, 1st or 2nd semester Bachelor CLS 2016 (compulsory), mathematics, 3rd or 5th semester Master Medical Informatics 2014 (optional subject), ehealth / infomatics, 1st or 2nd semester Master Computer Science 2012 (optional subject), specialization field medical informatics, 3rd semester Bachelor CLS 2010 (compulsory), mathematics, 3rd or 5th semester 				
Classes and lectures: • Genetic Epidemiology 1 (lecture, 2 S • Genetic Epidemiology 1 (exercise, 1	Workload:e, 2 SWS)• 60 Hours privateise, 1 SWS)• 45 Hours in-class		studies room work reparation	
Contents of teaching: Monogenic and complex diseases Hardy-Weinberg-equilibrium Coupling imbalance Genetic markers and genotyping Quality control Basics of association analysis Genome-wide association studies Population stratification Gene-environment interaction Replication, meta-analysis and imputation Ethical aspects				
 Qualification-goals/Competencies: Students are able to describe the generation of genetic data, its error sources and methods of detection. They can select and describe the most important approaches for genetic epidemiological association studies on the level of single markers. They are able to apply the basic test procedures manually and to interpret the results. They are able to describe the statistical evaluation steps in a genome-wide association study and interpret the results. 				
Grading through:Written or oral exam as announced by the examiner				
Is requisite for: • Seminar Genetic Epidemiology (MA5129-KP04, MA5129) • Genetic Epidemiology 2 (MA4661-KP08, MA4661)				
Requires: • Biostatistics 1 (MA1600-KP04, MA1600, MA1600-MML)				
Responsible for this module: • Prof. Dr. rer. nat. Silke Szymczak Teacher: • Institute of Medical Biometry and Statistics • Prof. Dr. rer. nat. Silke Szymczak • MitarbeiterInnen des Instituts				
Literature.				

• Ziegler A, König IR.: A statistical approach to genetic epidemiology. Concepts and applications. - 2010. ISBN: 978-3-527-32389-0



• Bickeböller H, Fischer, C: Einführung in die Genetische Epidemiologie - 2007. ISBN: 978-3-540-25616-8

Language:

• German or English

Notes:

Prerequisites for attending the module:

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

Prerequisites for the exam:

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

Module exam(s):

- MA3200-L1: Genetic Epidemiology 1, oral exam, 30 min, or written exam, 90 min, 100% of module grade



MA3400-KP04, MA3400 - Biomathematics (Biomathe)			
Duration:	Turnus of offer:		Credit points:
1 Semester	each winter semester		4
Course of study, specific field and term.			
 Master Molecular Life Science 2023 (Bachelor MES 2020 (optional subject) Bachelor Robotics and Autonomous Bachelor Medical Informatics 2014 (c Bachelor Computer Science 2014 (co Master MES 2011 (optional subject), Bachelor Medical Informatics 2011 (c Master Computer Science 2012 (optional subject)) Bachelor MES 2011 (optional subject) Bachelor MES 2011 (optional subject), Bachelor Medical Informatics 2011 (c Master Computer Science 2012 (optional subject)) Bachelor MES 2011 (optional subject) Bachelor MES 2011 (optional subject) 	optional subject), mathema), mathematics / natural sc Systems 2020 (optional su optional subject), medical c), mathematics / natural sc mpulsory), specialization fi mathematics, 1st semester optional subject), specialization), mathematics, 5th semest mpulsory), specialization fi	atics / computer science, 1s iences, 3rd semester at the bject), mathematics, 5th or omputer science, 5th or 6th iences, 3rd or 5th semester eld bioinformatics, 5th sem natics, 4th to 6th semester n field medical informatics, er eld bioinformatics, 5th sem	st semester earliest r 6th semester h semester nester 3rd semester
Classes and lectures:		Workload:	
 Biomathematics (lecture, 2 SWS) Biomathematics (exercise, 1 SWS) 		55 Hours private45 Hours in-class20 Hours exam p	studies and exercises room work reparation
Contents of teaching: • Examples and elementary solution n • Existence and uniqueness theorems • Dependence of solutions on initial co • Linear systems (in particular with con • Higher-Order linear differential equa • Qualitative theory of nonlinear syste • In accordance to the rules of GSP of	nethods for ordinary differe onditions nstant coefficients) tions ms UzL	ential equations	
Qualification-goals/Competencies: Students are able to explain basic no Based on examples, students are able Based on theorems, students are able Students are able to find explicit solutions Students are able to explain how solutions Students are able to present importations 	otions from the theory of or e to explain e to give conditions under utions of simple differentia utions of differential equat ant models of the natural so	rdinarydifferential equatior which l equations. ions can beanalysed qualit ciences which canbe analys	ns. atively. sed by differential equations.
Grading through: • written exam			
Requires: • Linear Algebra and Discrete Structur • Linear Algebra and Discrete Structur • Analysis 2 (MA2500-KP04, MA2500) • Analysis 1 (MA2000-KP08, MA2000)	es 2 (MA1500-KP08, MA150 es 1 (MA1000-KP08, MA100)0))0)	
Responsible for this module: • PD Dr. rer. nat. Christian Bey Teacher: • Institute for Mathematics • PD Dr. rer. nat. Christian Bey			
Literature: • G. Birkhoff, GC. Rota: Ordinary Diffe	rential Equations		



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

Language:

• offered only in German

Notes:

Prerequisites for the module:

- nothing

Prerequisites for admission to the written examination:

- Successful completion of homework assignments during the semester

Module exam:

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



MA4970 - Design of Experiments and Variance Analysis (VplVarianz)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	irregularly		4	
Course of study, specific field and term: • Master Computer Science 2012 (opt • Master CLS 2010 (optional subject), • Bachelor CLS 2010 (optional subject)	ional subject), specialization mathematics, 1st or 3rd sem), mathematics, 5th semeste	field medical informatics, ester r	3rd semester	
Classes and lectures:		Workload:		
 Design of Experiments and Variance Design of Experiments and Variance 	 Design of Experiments and Variance Analysis (lecture, 2 SWS) Design of Experiments and Variance Analysis (exercise, 1 SWS) 30 Hours in-class 25 Hours progra 15 Hours example 		studies room work nming reparation	
Contents of teaching:				
 Ability to calculate generalized inverse Knowledge of the differences between experiments and observational studies Knowledge of the advantages of the statistical design of multifactorial experiments Ability to interpret a suitable experimental ANOVA design Ability to implement a suitable experimental ANOVA design Ability to express the ANOVA model as regression model by matrix notation Ability to express and analyze models with repeated measurements Ability to draw up and analyze diagrams for an abstract of the results and a model diagnosis 				
Qualification-goals/Competencies: Comprehension of the theoretical p Comprehension of the theoretical p 	rinciples of the design of ex rinciples of the analysis of va	periments ariance		
Grading through: • written exam				
Requires: • Biostatistics 2 (MA2600-KP04, MA2600) • Linear Models (MA4960) • Biostatistics 1 (UngenutztMA1600-MML)				
Responsible for this module:				
Prof. Dr. rer. nat. Andreas Ziegler				
Teacher: Institute of Medical Biometry and Statistics				
Prof. Dr. rer. nat. Andreas Ziegler				
Literature:				
 Kursbuch: Montgomery, Douglas C. 2012: Design and Analysis of Experiments. 8th ed. International Student Version - John Wiley & Sons, New York. ISBN 978-1-118-09793-9 Supplementary literature: Kleppmann, Wilhelm. 2008: Taschenbuch Versuchsplanung. 5. Auflage - Carl Hanser, Wien. ISBN 978-3-446-41595-9 Supplementary literature: Mason, Robert L., Gunst, Richard F., Hess, James L. 2003: Statistical Design and Analysis of Experiments. 2nd ed John Wiley & Sons, New York. ISBN 0-471-37216-1 				
Language: • offered only in German				





ME4000 - Imaging Systems 1 (BildgbSys1)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each winter semester		4	
Course of study, specific field and term: • Master Computer Science 2012 (co • Master Computer Science 2012 (op • Master Computer Science 2012 (op • Master Computer Science 2012 (op • Master CLS 2010 (compulsory), cor	mpulsory), specialization fie ptional subject), advanced cu ptional subject), specializatio ptional subject), advanced cu nputational life science / ima	ld robotics and automation irriculum signal and image n field medical informatics, irriculum imaging systems, aging, 1st semester	, 1st semester processing, 2nd or 3rd semester 3rd semester 2nd or 3rd semester	
Classes and lectures:		Workload:		
 Imaging systems 1 (lecture, 2 SWS) Imaging systems 1 (exercise, 1 SW) 	2 SWS) • 55 Hours private 1 SWS) • 45 Hours in-class • 20 Hours exam p		studies room work reparation	
Contents of teaching:				
 Signal processing (recapitulation of fundamental principles in signal processing) Mathematical methods in image reconstruction and signal processing X-Ray (fundamental principles, quantum statistics) Computed Tomography * devices, * current and past technology, * signal processing, * Fourier-based 2D and 3D image reconstruction, * algebraic and statistical image reconstruction, * image artifacts, * technical and clinical applications, * dose. 				
Qualification-goals/Competencies:				
 Students are able to create an overview of the signal chain for medical imaging. They are able to explain the mathematical background for the reconstruction of CT images. They are able to explain the basics for the creation of X-ray. They are able to list all generations of CT devices and explain differences and advances. They are able to apply the Fourier transform. They are able to explain the mathematical basics for the two-dimensional image reconstruction. They are able to create and apply an algebraic approach for the reconstruction of CT images. They are able to create and apply an statistical approach for the reconstruction of CT images. They are able to outline the differences between two dimensional and three dimensional image reconstruction. They are able to transfer methods from two dimensional to three dimensional image reconstruction. 				
Grading through:				
Oral examination				
Responsible for this module: Prof. Dr. rer. nat. Thorsten Buzug Teacher: Institute of Medical Engineering Prof. Dr. rer. nat. Thorsten Buzug 				
 T. M. Buzug: Computed Tomography, From Photon Statistics to Modern Cone Beam CT - Springer-Verlag, Berlin/Heidelberg, 2008 T. M. Buzug: Einführung in die Computertomographie, Mathematisch-physikalische Grundlagen der Bildrekonstruktion - Springer-Verlag, Berlin/Heidelberg, 2004 				
Language:offered only in English				



ME4030-KP04, ME4030 - Inverse Problems in Imaging (InversProb)				
Duration:	Turnus of offer:	Credit points:		
1 Semester	each summer semester	4		
 Course of study, specific field and term: Master Auditory Technology 2022 (optional subject), Auditory Technology, 2nd semester Master MES 2020 (optional subject), medical engineering science, Arbitrary semester Master Medical Informatics 2019 (optional subject), medical image processing, 1st or 2nd semester Master Auditory Technology 2017 (optional subject), Auditory Technology, 2nd semester Master Auditory Technology 2017 (optional subject), Auditory Technology, 2nd semester Master MES 2014 (optional subject), medical engineering science, 1st or 2nd semester Master MES 2011 (optional subject), mathematics, 1st or 2nd semester Master Computer Science 2012 (optional subject), advanced curriculum signal and image processing, 2nd or 3rd semester Master Computer Science 2012 (optional subject), specialization field robotics and automation, 3rd semester Master Computer Science 2012 (optional subject), specialization field medical informatics, 3rd semester Master Computer Science 2012 (optional subject), advanced curriculum imaging systems, 2nd or 3rd semester Master MES 2011 (advanced curriculum), imaging systems, signal and image processing, 1st or 2nd semester Master CLS 2010 (optional subject), mathematics, 1st and 2nd semester 				
Classes and lectures:		Workload:		
 Tomographische Verfahren II: Invers Bildgebung (lecture, 2 SWS) Tomographische Verfahren II: Invers Bildgebung (exercise, 1 SWS) 	e Probleme bei der e Probleme bei der	 55 Hours private studies 45 Hours in-classroom work 20 Hours exam preparation 		
 Contents of teaching: Introduction to inverse and ill-posed conduction, computed tomography. Concept of ill-posedness of the inve Singular value decomposition and g Regularization methods (eg Tikhond Deconvolution Image restoration (deblurring, defoce Statistical methods (Bayes, maximur Computed Tomography, Magnetic F 	l problems on the basis of s , acoustic) rse problem (Hadamard) eneralized inverse w, Phillips, Ivanov) cusing) n likelihood) Particle Imaging	elected examples (including seismology, impedance tomography, heat		
Qualification-goals/Competencies:				
 Students are able to explain the concept of ill-posedness of the inverse problem and distinguish given inverse problems regarding good or bad posedness. They are able to formulate inverse problems of mathematical imaging and solve (approximate) with suitable numerical methods. They can assess the condition of a problem and the stability of a method. They master different regularization methods and are able to apply them to practical problems. They know methods to determine a suitable regularization. They can use methods of image reconstruction and restoration on real measurement data. 				
Grading through: • Written or oral exam as announced I	by the examiner			
Responsible for this module: • Prof. Dr. rer. nat. Thorsten Buzug Teacher: • Institute of Medical Engineering • Prof. Dr. rer. nat. Thorsten Buzug				
Kak and Slaney: Principles of Computer	Iterized Tomographic Imagi	ng - SIAM Series 33, New York, 2001		

• Natterer and Wübbeling: Mathematical Methods in Image Reconstruction - SIAM Monographs, New York 2001



- Bertero and Boccacci: Inverse Problems in Imaging IoP Press, London, 2002
- Andreas Rieder: Keine Probleme mit inversen Problemen Vieweg, Wiesbaden, 2003
- Buzug: Computed Tomography Springer, Berlin, 2008

Language:

offered only in German

Notes:

Prerequisites for attending the module:

- None

Prerequisites for the exam:

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



MZ3100-KP04, MZ3100 - Medical Quality Management (MedizQM)			
Duration:	Turnus of offer:	Credit points:	
1 Semester	each winter semester	4	
Course of study, specific field a • Bachelor MES 2020 (comp • Bachelor Medical Informa • Bachelor Medical Informa • Bachelor MES 2014 (comp • Master Computer Science • Bachelor MES 2011 (comp	nd term: pulsory), medicine, 3rd semester tics 2019 (optional subject), medica tics 2014 (optional subject), medica pulsory), medicine, 3rd semester 2012 (optional subject), specializat pulsory), medicine, 5th semester	al computer science, 4th to 6th semester al computer science, 5th or 6th semester tion field medical informatics, 3rd semester	
Classes and lectures.		Workload	
Medical Quality Managerr Medical Quality Managerr	Medical Quality Management (lecture, 2 SWS) Medical Quality Management (exercise, 1 SWS)		
 Part I: Medical Qualtity Ma Part II: Gauging, testing an Part III: Industrial Qualtity I 	anagement nd engineer standards Management		
 Part I: The students can cl basic terms of this subject expertise for independet psychometric tests. Part II: The students can id parameters to describe th processing (factual knowl supervision. They know th Part III: The students know technology branch (factual knowledge). 	assify the importance of quality ma t area and the contents of the EC D evaluations of clinical studies (emp dentify the important physiological ne measured signal quality (factual ledge) and they can analyze a invas ne contents of relevant safety, qual the basic components and requirer al knowledge). They are able to poi They know the specific qulity requi	anagement in the medical sector (procedural knowledge), they know the irectives and the Medical Devices Act (factual knowledge). They have the owerment) and the have factual knowledge sectors of quality assurance signals from the area of anesthesiology an they know the important knowledge). They have acquired knowledge in signal recording an sive blood preasure system (second-prder system) independently unter ity and testing standards (factual knowledge). ments of a industrial quality management system in the medical int out the difference between corporate objetives and quality objectives rements for medical software, hardware (MRI) and in-virto diagnostics	
Grading through:			
 written exam Responsible for this module: Prof. Dr. med. Hartmut Ge Teacher: Institute of Medical Engin 	hring eering		
• Prof. Dr. med. Hartmut Ge	hring		
Literature: • Böckmann, Frankenberge • Jahnke, I., Friedrich, HJ. & differenziert sollte eine Au • Lauterbach, Lüngen, Schr GmbH, ISBN 978-3-7945-2 • Frodel: BWL für Mediziner • Lauterbach, Stock, Brunne Language:	er, und Wille: MPG und Co 7. akt. / & Hüppe, M. (2002): Die Lübecker F uswertung für das Qualitätsmanage appe: Gesundheitsökonomie, Mana 2576-8 r - 2008, Walter de Gruyter & Co. KO er: Gesundheitsökonomie - 2. Aufla	Auflage 2015, TÜV-Verlag GmbH Köln, ISBN: 978-3-8429-1843-0 ragebogen-Doppelkarte zur Erfassung der Patientenzufriedenheit: Wie ement erfolgen? - FOCUS MUL, 19,/ 82-91 agement und Evidence-based Medicine 3. Auflage 2010, Schattauer 5, ISBN: 978-3-11-020112-3 ge 2009, Verlag Hans Huber, ISBN 978-3-456-84695-8	



• offered only in German

Notes:

Prerequisites for attending the module: - None

- - - -

Prerequisites for the exam:

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





MZ4010-KP04, MZ4010 - Clinical Epidemiology (KlinEpi)					
Duration:	Turnus of offer:		Credit points:		
1 Semester	each winter semester		4		
 Course of study, specific field and term: Master CLS 2023 (compulsory), MML with specialization in Genetic Statistics, 3rd semester Bachelor Medical Informatics 2019 (optional subject), medical computer science, 4th to 6th semester Master CLS 2016 (compulsory), MML with specialization in Genetic Statistics, 3rd semester Bachelor Medical Informatics 2014 (compulsory), medical computer science, 5th semester Bachelor Medical Informatics 2011 (compulsory), medical computer science, 3rd semester Master CLS 2010 (compulsory), computational life science / biostatistics, 1st semester Master Cuse 2012 (compulsory), specialization field medical informatics, 3rd semester 					
Classes and lectures:		Workload:			
 Clinical Epidemiology (lectule) Clinical Epidemiology (exertion) 	 Clinical Epidemiology (lecture, 2 SWS) Clinical Epidemiology (exercise, 1 SWS) Store and exercises 45 Hours in-classroom work 20 Hours exam preparation 				
Contents of teaching:					
 Diagnosis Frequencies Registers and data sources Geographical epidemiology Study designs (RCT, cohort Effect measures Causality Chance, bias and confound Control of errors Outbreak investigation 	 Introduction to epidemiology Diagnosis Frequencies Registers and data sources Geographical epidemiology Study designs (RCT, cohort study, case control study, cross sectional study) Effect measures Causality Chance, bias and confounding Control of errors Outbreak investigation 				
Qualification-goals/Competencie	S:	•, • •,	. P. 1 .1 P 1 P		
 Students are able to explain technical terms such as disease register, incidence, prevalence, mortality, lethality, standardization. They are able to explain and interpret epidemiological measures. They are able to assess which study design is appropriate for a certain research question. They are able to identify possible sources of error, bias and confounding and how they affect the study results. They are able to assess causal inferences in the context of different study types. They are able to critically appraise data, results, and epidemiological research methods as well as scientific literature in the context of medicine and epidemiology. 					
Grading through:					
• written exam					
Responsible for this module: • Prof. Dr. med. Alexander Katalinic Teacher: • Institute for Social Medicine and Epidemiology • Prof. Dr. med. Alexander Katalinic • MitarbeiterInnen des Instituts					
Literature:					
 L. Gordis: Epidemiology - Oxford: Elsevier; 5th edition 2013 R. H. Fletcher: Clinical Epidemiology. The Essentials Lippincott Williams & Wilki; 5th rev. edition 2012 : 					
Language:					



• offered only in German

Notes:

Prerequisites for attending the module: - None

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

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



MZ40)20 - Procedures for clinical dia	agnostic and therapy (VkDiagTher)	
Duration:	Turnus of offer:	Credit points:	
1 Semester	each summer semester	4	
Course of study, specific field a	nd term:	t medical informatics. and somester	
Classes and lectures:	anastic and thorapy (lasture 2 CIMC)	Workload:	
 Procedures for clinical dia Procedures for clinical dia 	gnostic and therapy (exercise, 1 SWS)	 45 Hours in-classroom work 20 Hours exam preparation 	
Contents of teaching: Diagnosefindung (Anamn Organ bzw. teilgebietsorie Kardiologie/Gef aßerkrant Lungenembolie) Pulmonologie (z.B. Pneum Gastroenterologie (z.B. Diabe Endokrinologie (z.B. Diabe Nephrologie (z.B. akutes N Hämatologie und Onkolog Infektionskrankheiten (z.B Rheumatologie (z.B. Rheu	 Contents of teaching: Diagnosefindung (Anamnese, Befund) Organ bzw. teilgebietsorientierte Darstellung von internistischen Erkrankungen Kardiologie/Gef aßerkrankungen (z.B. Art. Hypertonie, arterielle Verschlusskrankheiten,Herzinfarkt, Rhythmusstörungen, Schock, Lungenembolie) Pulmonologie (z.B. Pneumonie, Asthma, chronologisch obstruktive Lungenerkrankung) Gastroenterologie (z.B. Ulcuserkrankung, entzündliche Darmerkrankungen,Pankratitis, Hepatitis, Colon-Ca) Endokrinologie (z.B. Diabetes, Schilddrüsen- und Nebennierenfunktionsstörung) Nephrologie (z.B. akutes Nierenversagen, Glomerulonephritis, Dialyse) Hämatologie und Onkologie (z.B. Anämie, Hämolyse, Plasmozytom, Lymphom) Infektionskrankheiten (z.B. Varizellen, Scharlach, Tbc, HIV, Sepsis) Rheumatologie (z.B. Rheumatoide Arthritis, Polymyalgiarheumatica) 		
 Übersicht über die Symptomatik, Diagnostik und Therapie ausgewählter Krankheiten aus den verschiedenen Bereichen der Inneren Medizinerapie Einblick in Methoden ärztlichen Handelns Anwendung medizinischer Grundkenntnisse auf ausgewählte Krankheitsbilder Befähigung zur selbstständigen Einarbeitung in einzelne Krankheitsbilder bei gegebenen Fragestellungen 			
Grading through: • written exam			
Responsible for this module: • Prof. Dr. med. Hendrik Lehnert Teacher: • Medical Clinic I • Dr. med. Peter Wellhöner			
 Literature: H. Renz-Polster, J. Braun: Basislehrbuch Innere Medizin - 3. Auflage. München: Urban und Fischer L. Geisler: Innere Medizin - Stuttgart: Kohlhammer 2002 			
offered only in German			





	CS4170 - Parallel C	omputer Systems (Pa	araRSys)
Duration:	Turnus of offer:		Credit points:
1 Semester	not available anymo	pre	4
Course of study, specific fie • Master Computer Scie • Master Computer Scie	eld and term: ence 2012 (optional subject), advance ence 2012 (optional subject), speciali	ed curriculum parallel and d zation field robotics and a	distributed system architecutres, 2nd or 3rd semes utomation, 3rd semester
Classes and lectures:		Workload:	
Parallel Computer SystemParallel Computer System	 Parallel Computer Systems (lecture, 2 SWS) Parallel Computer Systems (exercise, 1 SWS) Parallel Computer Systems (exercise, 1 SWS) 20 Hours exam preparation 		
Contents of teaching:			
 Parallel computing m Taxonomy of parallel Multi/manycore-syste Graphic Processing U OpenCL Specification languag Hardware architectur System management 	iodels computers ems nits (GPUs) jes es of many-core systems		
 They are able to expla They are able to make They are able to judg used. They are able to evalue They are able to write They are able to com Grading through: Written or oral example 	ain models of parallel computing. e use of common programming inter e which kind of parallel computing s uate the pros and cons of different h e programs for parallel computing sy pare methods for dynamic voltage a	rfaces for parallel computi system is best suited for a c ardware architectures. stems under consideration nd frequency scaling (DVF	ng systems. dedicated problem and how many cores should b ns of the underlying hardware architecture. 'S) for manycore systems.
Prof. DrIng. Thilo Pic Teacher: Institute of Computer Prof. DrIng. Thilo Pic	e: onteck (Nachfolger NN) ⁻ Engineering onteck (Nachfolger NN)		
Literature: G. Bengel, C. Baun, M M. Dubois, M. Annava B. R. Gaster, L. Howes B. Wilkinson; M. Allen J. Jeffers, J. Reinders: D. A. Patterson, J. L. H	. Kunze, K. U. Stucky: Masterkurs Para aram, P. Stenström: Parallel Compute , D. R. Kaeli, P. Mistry, D. Schaa: Heter : Parallel Programming - Englewood Intel Xeon Phi Coprozessor High-Per lennessy: Computer Organization an	allele und Verteilte System r Organization and Desigr rogeneous Computing wit Cliffs: Pearson 2005 formance Programming - d Design - Morgan Kaufma	e - Vieweg + Teubner, 2008 n - University Press 2012 ch OpenCL - Elsevier/Morgan Kaufman 2013 Elsevier/Morgan Kaufman 2013 ann, 2013
Language: • offered only in Germa	in		
Notes			
Only CS4170-KP06 Para	llel Computer Systems is now offered	d for 6 credits.	





CS4172-KP04, CS4172 - Dependability of Computing Systems (ZuverlRSys)			
Duration:	Turnus of offer:		Credit points:
1 Semester	each summer semester		4
Course of study, specific field and term: Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 5th or 6th semester Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester Bachelor IT-Security 2016 (compulsory), IT-Security, 6th semester Bachelor Computer Science 2014 (optional subject), central topics of computer science, 6th semester Bachelor Computer Science 2014 (compulsory), specialization field IT security and safety, 6th semester Bachelor Computer Science 2012 (compulsory), specialization field IT security and safety, 6th semester Master Computer Science 2012 (optional subject), advanced curriculum security, 2nd or 3rd semester Master Computer Science 2012 (optional subject), advanced curriculum parallel and distributed system architecutres, 2nd or 3rd semester Master Computer Science 2012 (optional subject), specialization field robotics and automation, 3rd semester 			
Classes and lectures:		Workload:	
 Dependability of Computing System Dependability of Computing System 	s (lecture, 2 SWS) s (exercise, 1 SWS)	 55 Hours private 45 Hours in-classi 20 Hours exam private 	studies room work reparation
 Basic terms General redundancy techniques Fault diagnosis Reconfiguration and recovery Fault masking Examples for fault-tolerant systems 	 Basic terms General redundancy techniques Fault diagnosis Reconfiguration and recovery Fault masking Examples for fault-tolerant systems 		
 Qualification-goals/Competencies: The students are able to present the most important fault types in hardware and software and their abstraction to fault models. They are able to elucidate the basic redundancy techniques (static and dynamic redundancy, hybrid forms etc.). They are able to explain various methods for fault diagnosis, reconfiguration, recovery and fault masking. They are able to describe typical application examples and sample fault-tolerant computers. They are able to analyze fault tolerance techniques quantitatively by mathematical reliability models. They are able to valuate and compare suitable fault tolerance techniques and to select them for a given application area. 			
Grading through: • Written or oral exam as announced b	by the examiner		
Responsible for this module: • Prof. DrIng. Mladen Berekovic Teacher: • Institute of Computer Engineering • Prof. DrIng. Mladen Berekovic Literature: • E. Dubrova: Fault-Tolerant Design - Springer 2013 • K. Echtle: Fehlertoleranzverfahren - Springer 1990 • I. Koren, C. M. Krishna: Fault Tolerant Systems - Morgan-Kaufman 2007 • K. Trivedi: Probability and Statistics with Reliability, Queuing, and Computer Science Applications - Wiley 2001			
Language: • offered only in German			



Notes:

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- Successful completion of exercise assignments as specified at the beginning of the semester

Module Exam(s):

- CS4172-L1: Dependability of Computing Systems, written exam, 90min, 100% of the module grade



CS4250-KP04, CS4250 - Computer Vision (CompVision)				
Duration:	Turnus of offer:	Credit points:		
1 Semester	each summer semester	4		
 Course of study, specific field and term: Master CLS 2023 (optional subject), computer science, 2nd or 3rd semester Master MES 2020 (optional subject), computer science / electrical engineering, Arbitrary semester Master Computer Science 2019 (optional subject), Elective, Arbitrary semester Master Media Informatics 2020 (optional subject), Elective, Arbitrary semester Master Biophysics 2019 (optional subject), Elective, Arbitrary semester Master Biomedical Engineering (optional subject), advanced curriculum, 2nd semester Master KES 2014 (optional subject), computer science, 2nd or 3rd semester Master MES 2014 (optional subject), computer science, 2nd or 3rd semester Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester Master Computer Science 2012 (optional subject), computer science, Arbitrary semester Master CLS 2010 (compulsory), computational life science / imaging, 2nd semester Master MES 2011 (advanced curriculum), imaging systems, signal and image processing, 2nd semester Master Computer Science 2012 (optional subject), advanced curriculum signal and image processing, 2nd or 3rd semester Master Computer Science 2012 (optional subject), advanced curriculum signal and image processing, 2nd or 3rd semester Master Computer Science 2012 (optional subject), advanced curriculum signal and image processing, 2nd semester Master Computer Science 2012 (optional subject), advanced curriculum signal and image processing, 2nd semester Master Computer Science 2012 (compulsory), specialization field bioinformatics, 2nd semester Master Computer Science 2012 (compulsory), specialization field bioinformatics, 2nd semester Master Computer Science 2012 (compulsory), specialization field bioinformatics, 2nd semester <				
Classes and lectures:		Workload:		
 Computer Vision (lectur Computer Vision (exerci 	re, 2 SWS) ise, 1 SWS)	 55 Hours private studies 45 Hours in-classroom work 20 Hours exam preparation 		
Contents of teaching: Introduction to human and computer vision Sensors, cameras, optics and projections Image features: edges, intrinsic dimension, Hough transform, Fourier descriptors, snakes Range imaging and 3-D cameras Motion and optical flow Object recognition Example applications 				
 Qualification-goals/Competencies: Students can understand the basics of computer vision. They can explain and perform camera choice and calibration. They can explain and apply the basic methods for feature extraction, motion estimation, and object recognition. They can indicate appropriate methods for different kinds of computer-vision applications. 				
Grading through: • Oral examination				
Responsible for this module: Prof. DrIng. Erhardt Barth Teacher: Institute for Neuro- and Bioinformatics Prof. DrIng. Erhardt Barth 				
Literature: Richard Szeliski: Computer Vision: Algorithms and Applications - Springer, Boston, 2011 David Forsyth and Joan Ponces Computer Vision: A Modern Approach - Breatice Hall 2003				
Language:				



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CS4405-KP04, CS4405 - Neuroinformatics (NeuroInf)			
Duration:	Turnus of offer:		Credit points:
1 Semester	each summer semester		4
 Course of study, specific field and term: Master CLS 2023 (compulsory), computer science, 2nd semester Master Auditory Technology 2022 (optional subject), Auditory Technology, 2nd semester Master Auditory Technology 2017 (optional subject), Auditory Technology, 2nd semester Master MES 2020 (optional subject), computer science / electrical engineering, Arbitrary semester Master CLS 2016 (compulsory), computer science, 2nd semester Master Robotics and Autonomous Systems 2019 (optional subject), Elective, 1st or 2nd semester Master MES 2014 (optional subject), computer science / electrical engineering, Arbitrary semester Master MES 2014 (optional subject), computer science / electrical engineering, Arbitrary semester Master MES 2011 (optional subject), mathematics, 2nd semester 			
 Bachelor MES 2011 (optional subject Master Computer Science 2012 (optional subject Master MES 2011 (advanced curricule) Master Computer Science 2012 (optional subject Master Computer Science 2012 (cotex) Master CLS 2010 (compulsory), contex 	ct), optional subject medical tional subject), advanced cu Ilum), imaging systems, sign tional subject), advanced cu mpulsory), specialization fiel mpulsory), specialization fiel nputer science, 2nd semester	engineering science, 6th s rriculum organic computin al and image processing, 2 rriculum intelligent embed d robotics and automation d bioinformatics, 2nd seme	emester Ig, 2nd or 3rd semester Ind semester Ided systems, 2nd or 3rd semester I, 2nd semester ester
Classes and lectures:		Workload:	
 Neuroinformatics (lecture, 2 SWS) Neuroinformatics (exercise, 1 SWS) 		55 Hours private45 Hours in-class20 Hours exam p	studies room work reparation
 Contents of teaching: The human brain and abstract neu Learning with a single neuron:* Per Network architectures:* Hopfield-N Unsupervised Learning:* k-means, 	ron models rceptrons* Max-Margin Class letworks* Multilayer-Percept Neural Gas and SOMs* PCA &	ification* LDA and logistic rons* Deep Learning & ICA* Sparse Coding	Regression
Qualification-goals/Competencies:			
 The students are able to understan They know abstract neuronal mode They are able to derive a learning r They are able to apply (and implending the state of the sta	d the principle function of a els and they are able to name ule from a given error function nent) the proposed learning	single neuron and the bra e practical applications for on. rules and approaches to sc	in as a whole. the different variants. olve unknown practical problems.
Grading through:			
Written or oral exam as announced	by the examiner		
Responsible for this module:			
 Prof. Dr. rer. nat. Thomas Martinetz 			
Institute for Neuro- and Bioinforma	tics		
 Prof. Dr. rer. nat. Thomas Martinetz Prof. Dr. rer. nat. Amir Madany Man 	nlouk		
Literature:			
 S. Haykin: Neural Networks - Londo J. Hertz, A. Krogh, R. Palmer: Introd T. Kohonen: Self-Organizing Maps - H. Ritter, T. Martinetz, K. Schulten: I Addison Wesley, 1991 	n: Prentice Hall, 1999 uction to the Theory of Neur Berlin: Springer, 1995 Neuronale Netze: Eine Einfüh	al Computation - Addison rung in die Neuroinformat	Wesley, 1991 ik selbstorganisierender Netzwerke - Bonn:
Language:			



• offered only in German

Notes:

Admission requirements for taking the module:

- None

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

Module Exam(s):

- CS4405-L1: Neuroinformatics, written exam, 90 min, 100% of module grade

According to the old version of the MES Bachelor Examination Regulations (until WS 2011/2012), an elective subject is scheduled for the 4th semester instead of the 6th semester.



CS4660-KP04, CS4660 - Process Control Systems (ProzFueSys)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each winter semester		4	
 Course of study, specific field and term: Master Robotics and Autonomous Systems 2019 (optional subject), Module part Current Issues Robotics and Automation, Arbitrary semester Master Psychology 2016 (optional subject), interdisciplinary competence, 3rd semester Master psychology 2013 (optional subject), interdisciplinary competence, 3rd semester Master Media Informatics 2014 (compulsory), computer science, 3rd semester Master Computer Science 2012 (optional subject), specialization field robotics and automation, 2nd or 3rd semester Master Computer Science 2012 (compulsory), specialization field media informatics, 2nd semester Master Entrepreneurship in Digital Technologies 2020 (optional subject), specific, Arbitrary semester 				
Classes and lectures:		Workload:		
 Process Control Systems (lecture, 2 S) Process Control Systems (exercise, 1 s) 	 Process Control Systems (lecture, 2 SWS) Process Control Systems (exercise, 1 SWS) Statistical descention Statistical desc		studies room work reparation	
Contents of teaching: Introduction and Overview Incidents and Accidents Error, Failure and Responsibility Human Factors Mental, conceptual and technical Models Task Analysis and Task Modelling Event Analysis and Event Modelling Task Allocation Situation Awareness Diagnoses und Contingency Interaction in real-time: Conception and Design Risk and Safety				
 Qualification-goals/Competencies: The students know the most important theories, methods and systems for monitoring and controlling processes. They know the definitions of the terms risk and security and why they are applied in different ways. They can assess what needs to be considered in the development of mission- and safety-critical human-machine systems and how to proceed methodically. 				
Grading through: • written exam				
 Responsible for this module: Prof. Dr. phil. André Calero Valdez Teacher: Institute for Multimedia and Interactive Systems Prof. Dr. phil. André Calero Valdez Literature: M. Herczeg: Prozessführungssysteme Sicherheitskritische Mensch-Maschine-Systeme und Interaktive Medien zur Überwachung und Steuerung von Prozessen in Echtzeit - München: de Gruyter - Oldenbourg-Verlag, 2014 M. Herczeg: Software-Ergonomie: Theorien, Modelle und Kriterien für gebrauchstaugliche interaktive Computersysteme - 4. erweiterte und aktualisierte Auflage. De Gruyter Studium, 2018 M. Herczeg: Interaktionsdesign - München: Oldenbourg-Verlag, 2006 J. Reason: Human Error - Boston: Cambridge University Press, 1990 Laramuscen L. B. Geodettein A. M. Beitperson: Compitige University Press, 1990 				



Language:

• offered only in German

Notes:

Prerequisites for attending the module: - None

Prerequisites for the exam:

- Successful completion of homework assignments during the semester.



	CS5150-KP04, CS5150 - Organic Computing (OrganicCom)				
Duration:	Turnus of offer:		Credit points:		
1 Semester	irregularly		4		
Course of study, specific f	ield and term:				
 Master Entrepreneu Master Medical Info Master Medical Info Master Computer Sc Master CLS 2010 (op Master Computer Sc Master Computer Sc Master Computer Sc 	rship in Digital Technologies 2020 (advar rmatics 2019 (optional subject), bioinform rmatics 2014 (optional subject), bioinform ience 2012 (optional subject), advanced c otional subject), computer science, Arbitr cience 2012 (compulsory), advanced curri cience 2012 (optional subject), specializat	nced module), specific, Arbiti natics, 1st or 2nd semester natics, 1st or 2nd semester curriculum parallel and distrik ary semester iculum organic computing, 2 cion field robotics and autom	rary semester outed system architecutres, 2nd or 3rd semester 2nd or 3rd semester nation, 3rd semester		
Classes and lectures:		Workload:			
Organic ComputingOrganic Computing	(lecture, 2 SWS) (exercise, 1 SWS)	NS) • 60 Hours private studies SWS) • 45 Hours in-classroom work • 15 Hours exam preparation			
Contents of teaching:					
 Basic principles of C Self-organization an Architecture and de Organic Computing Organic Computing Organic Grid Autonomous Syster 	nganic computing ad emergence isign of Organic Computing systems for distributed systems in Neuro- and Bionformatics ns				
Qualification-goals/Comp	etencies:				
Students are able toThey are able to expThey are able to ana	o utilize the principles of organic compution blain the principles of Organic Computing alyze emergence behavior in Organic Cor	ing on exemplary designs. g. nputing systems.			
Grading through:					
• written exam					
Responsible for this modu	ıle:				
Prof. DrIng. Mlader	n Berekovic				
Teacher:	- For stars and a				
Institute of Compute	er Engineering				
• Dr. rer. nat. Javad Gl	nofrani				
Literature:					
 C. Müller-Schloer, H R. P. Würtz: Organic C. Klüver, J. Kluever, 	. Schmeck, T. Ungerer: Organic Computin Computing - Springer, 2008 J. Schmidt: Modellierung komplexer Pro	ng A Paradigm Shift for Cor zesse durch naturanaloge Ve	nplex Systems - Birkhäuser, 2011 erfahren - Springer Vieweg 2012		
Language:					
offered only in Gern	nan				
Notes:					



Admission requirements for taking the module: - None

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

Module Exam(s):

- CS5150-L1: Organic Computing, oral exam, 100% of the module grade



CS5170-KP04, CS5170 - Hardware/Software Co-Design (HWSWCod)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each winter semester		4	
 Course of study, specific field and term: Master Computer Science 2019 (compulsory), Canonical Specialization SSE, Arbitrary semester Master Computer Science 2019 (optional subject), Elective, Arbitrary semester Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester Master Robotics and Autonomous Systems 2019 (optional subject), Elective, 1st or 2nd semester Master Computer Science 2014 (compulsory), specialization field software systems engineering, 1st or 2nd semester Master MES 2011 (advanced curriculum), imaging systems, signal and image processing, 1st or 3rd semester Master Computer Science 2012 (optional subject), specialization field robotics and automation, 2nd or 3rd semester Master Computer Science 2012 (optional subject), advanced curriculum parallel and distributed system architecutres, 2nd or 3rd semester Master Computer Science 2012 (optional subject), advanced curriculum intelligent embedded systems, 2nd or 3rd semester Master Computer Science 2012 (optional subject), advanced curriculum intelligent embedded systems, 2nd or 3rd semester Master Computer Science 2012 (optional subject), advanced curriculum intelligent embedded systems, 2nd or 3rd semester Master Computer Science 2012 (optional subject), advanced curriculum intelligent embedded systems, 2nd or 3rd semester Master Computer Science 2012 (optional subject), advanced curriculum intelligent embedded systems, 2nd or 3rd semester 				
Classes and lectures:		Workload:		
 Hardware/Software Co-Design (lectule) Hardware/Software Co-Design (exerult) 	ure, 2 SWS) cise, 1 SWS)	55 Hours private45 Hours in-class20 Hours exam p	studies room work reparation	
 And water bottwate Corbestign (exercise, FSW2) 20 Hours exam preparation 20 Hours examples Qualification-goals/Competencies: 21 Adjoint Hours examples Qualification examples Qualification examples Qualification examples Our able to determine and describe the pros and cons of implementation alternatives 21 They are able to determine and describe the pros and cons of implementation alternatives 22 They are able to translate non-formal system descriptions into formal models 23 They are able to cestimate the quality of system descriptions into formal models 24 They are able to cestimate the quality of system descriptions in System C Grading through: Written or oral exam as announced by the examiner 			em description s	
Responsible for this module:				
Prof. DrIng. Mladen Berekovic				
Teacher:				
Institute of Computer Engineering Prof. Dr. Ing. Minder Perelsuits				
• Prot. Dring. Miaden Berekovic				
Literature: • F. Kesel: Modellierung von digitalen • Teich, J., Haubelt, C.: Digital Hardwa	Systemen mit SystemC - Ol re/Software-Systeme. Synth	denbourg Verlag 2012 ese und Optimierung - Ber	lin: Springer 2007	



Language:

• offered only in German

Notes:

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- Successful completion of exercise assignments as specified at the beginning of the semester

Module Exam(s):

- CS5170-L1: Hardware/Software Co-Design, oral exam, 100% of the module grade



	CS5204-KP04, CS5204 - A	Artificial Intelligence 2 (KI2)
Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4
Course of study, specific field a Master MES 2020 (optional Master Robotics and Autor Master Biophysics 2019 (c Master MES 2014 (optional Master CLS 2016 (optional Master CLS 2016 (optional	and term: al subject), computer science / electric promous Systems 2019 (optional subj optional subject), Elective, 1st semeste al subject), computer science / electric eering (optional subject), Interdisciplir Il subject), computer science, 3rd sem	cal engineering, Arbitrary semester ject), Elective, 1st or 2nd semester er cal engineering, Arbitrary semester nary modules, 2nd semester jester
 Master Computer Science Master Computer Science 	e 2012 (optional subject), advanced ct e 2012 (optional subject), specializatio	in field robotics and automation, 3rd semester
Classes and lectures:		Workload:
 Artificial Intelligence 2 (le Artificial Intelligence 2 (e) 	(lecture, 2 SWS)• 55 Hours private studies(exercise, 1 SWS)• 45 Hours in-classroom work• 20 Hours exam preparation	
Contents of teaching: • Support Vector Machines • Classification • Regression • Time-Series Prediction • Lagrange Multipliers	and Dualization	
 Sequential Minimal Optin Geometric Reasoning 	nization	
 Qualification-goals/Competend The students are able to a The chosen method can be search of parameters and learning, designed and in 	cies: choose a method for machine learnin be customized to the needs of the ap I involves adjustments to the basic ma nplemented by the students.The start	g for a given application amongst a variety of such methods. plication. The process of customization goes well beyond straightforwar athematical techniques.This leads to innovative applications for machine ting point are support vector machines.
Grading through:		
Oral examination		
Responsible for this module: • Prof. DrIng. Achim Schw Teacher: • Institute for Robotics and	eikard Cognitive Systems	
• Proi. Dring. Achim SCNW	eikaiu	
Literature: • P. Norvig, S. Russell: Küns	tliche Intelligenz - München: Pearson	2004
Language: • offered only in English		
Notes:		



Note: Module will not be offered in winter semester 2024/2025

Admission requirements for taking the module:

- None

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

Module Exam(s): - CS5204-L1: Artificial Intelligence 2, written exam, 90min, 100% of the module grade



CS5255 - Elements of Audio and Image Coding (AudioBild)				
Duration:	Turnus of offer: Credit points:		Credit points:	
1 Semester	irregularly		4	
 Course of study, specific field and term: Master CLS 2010 (optional subject), imaging systems, Arbitrary semester Master Computer Science 2012 (optional subject), advanced curriculum signal and image processing, 2nd or 3rd semester Master Computer Science 2012 (optional subject), specialization field robotics and automation, 3rd semester Master Computer Science 2012 (optional subject), specialization field media informatics, 2nd or 3rd semester 				
Classes and lectures:		Workload:		
 Elements of Audio and Image Coding Elements of Audio and Image Coding 	Elements of Audio and Image Coding (lecture, 2 SWS)• 55 Hours private stureElements of Audio and Image Coding (exercise, 1 SWS)• 45 Hours in-classroo• 20 Hours exam prep		studies sroom work preparation	
Contents of teaching:				
 Introduction to information theory Fundamentals of data compression and quantization Wavelets, transforms, and filterbanks for coding Principles of perceptual audio coding Standardized audio coders, such as mp3 and AAC Lossless audio coding Principles and standards of image compression (JPEG, JPEG2000) Progressive image compression Visual perception and masking Principles of video coding Principles of error correction and concealment 				
Qualification-goals/Competencies:				
 Students are able to describe the different models of auditory and visual perception. They are able to implement optimal transforms and coding techniques. They are able to explain various applications of the above mentioned principles in audio, image, and video coding. 				
Grading through:Written or oral exam as announced by the examiner				
Responsible for this module: Prof. DrIng. Alfred Mertins Teacher: Institute for Signal Processing Prof. DrIng. Alfred Mertins 				
Literature:				
• K. Sayood: Introduction to Data Com	pression - San Diego: Acad	demic Press, 2nd edition 20	00	
Language: • offered only in German				
Notes:				



Prerequisites for attending the module: - None

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

Modul exam:

- CS5255-L1: Elements of Audio and Image Coding, written or oral exam, 100% of modul grade



CS5260 - Digital Speech and Audio Signal Processing (SprachAudi)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	not available anymore		4	
Course of study, specific field and term: Master Computer Science 2012 (opt Master MES 2011 (advanced curricul Master Computer Science 2012 (opt Master Computer Science 2012 (opt Master Computer Science 2012 (opt	ional subject), advanced cu lum), imaging systems, sign ional subject), advanced cu ional subject), specialization ional subject), specialization	rriculum signal and image ral and image processing, 1 rriculum intelligent embed n field robotics and automa n field media informatics, 2	processing, 2nd or 3rd semester st or 2nd semester Ided systems, 2nd or 3rd semester ation, 3rd semester Ind or 3rd semester	
Classes and lectures:		Workload:		
 Digital Speech and Audio Signal Pro Digital Speech and Audio Signal Pro 	rocessing (lecture, 2 SWS)• 55 Hours private studiesrocessing (exercise, 1 SWS)• 45 Hours in-classroom work• 20 Hours exam preparation		studies room work reparation	
Contents of teaching:				
 Speech production and human hearing Physical models of the auditory System Dynamic compression Spectral analysis: Spectrum and Cepstrum Spectral perception and masking Vocal tract models Linear prediction Coding in time and frequency domains Speech synthesis Noise reduction and echo compensation Source localization and spatial reproduction Basics of automatic speech recognition 				
Qualification-goals/Competencies:	Oualification-goals/Competencies:			
 Students are able to describe the ba They are able to describe the proces auditory perception. They are able to present basic know They can describe and use signal pro- 	 Students are able to describe the basics of human speech production and the corresponding mathematical models. They are able to describe the process of human auditory perception and the corresponding signal processing tools for mimicing auditory perception. They are able to present basic knowledge of statistical speech modeling and automatic speech recognition. They can describe and use signal processing methods for source separation and room-acoustic measurements. 			
Grading through:				
Written or oral exam as announced	by the examiner			
Responsible for this module: Prof. DrIng. Alfred Mertins Teacher: Institute for Signal Processing Prof. DrIng. Alfred Mertins 				
Literature:				
 L. Rabiner, BH. Juang: Fundamenta J. O. Heller, J. L. Hansen, J. G. Proakis 	Is of Speech Recognition - Discrete-Time Processing	Upper Saddle River: Prentic of Speech Signals - IEEE Pre	e Hall 1993 ess	
Language: • offered only in German				



CS5270 - Mobile Robots (MobilRob)			
Duration:	Turnus of offer: Credit points:		
1 Semester	not available anymore		4
Course of study, specific field and term: • Master Computer Science 2012 (opti • Master Computer Science 2012 (com • Master Computer Science 2012 (opti	onal subject), advanced cu pulsory), specialization fiel onal subject), advanced cu	rriculum intelligent embed d robotics and automation rriculum organic computin	ded systems, 2nd or 3rd semester , 1st semester g, 3rd semester
Classes and lectures:Workload:• Mobile Robots (lecture, 2 SWS)• 55 Hours private studies• Mobile Robots (exercise, 1 SWS)• 45 Hours in-classroom work• 20 Hours exam preparation			studies room work reparation
Contents of teaching: • Reactive behaviour • Sensors • Actuators, kinematics of the drives • Hybrid deliberative/reactive behaviour • Strategies of actions • maps, self-localization • Routing and navigation • Robot learning • Multi-robots • Human-robot interaction • Currentds trends exempary robots			
 Qualification-goals/Competencies: Students know the most importent types of mobile autonomous robots (wheel-driven, walking and climbing robots etc.) and their kinematics. They have developed an understanding of sensors and actuators and their application to robotics They understand the basic methods of self-localization, planning and navigation and can apply them to real applications They are able to design and to program mobile robots 			
Grading through: • Written or oral exam as announced b	by the examiner		
Responsible for this module: • Prof. DrIng. Mladen Berekovic Teacher: • Institute of Computer Engineering • Prof. DrIng. Mladen Berekovic Literature:			
• : • : • :			
Language: • offered only in German			



CS5275-KP04, CS5275 - Selected Topics of Signal Analysis and Enhancement (AMSAV)			
Ouration: Turnus of offer:		Credit points:	Credit points:
1 Semester	every second semester		4
1 Semester 4 Course of study, specific field and term: 4 • Master MES 2020 (optional subject), medical engineering science, Arbitrary semester • Master Medical Informatics 2019 (optional subject), Medical Data Science / Artificial Intelligence, 1st or 2nd semester • Master MES 2014 (optional subject), medical engineering science, Arbitrary semester • Master Medical Informatics 2014 (optional subject), medical image processing, 1st or 2nd semester • Master Medical Informatics 2014 (optional subject), computer science, Arbitrary semester • Master CLS 2010 (optional subject), computer science, Arbitrary semester • Master Computer Science 2012 (optional subject), specialization field bioinformatics, 3rd semester • Master MES 2011 (advanced curriculum), imaging systems, signal and image processing, 1st or 2nd semester • Master Computer Science 2012 (optional subject), advanced curriculum signal and image processing, 2nd or 3rd semester • Master Computer Science 2012 (optional subject), specialization field robotics and automation, 3rd semester • Master Computer Science 2012 (optional subject), advanced curriculum intelligent embedded systems, 2nd or 3rd semester • Master Computer Science 2012 (optional subject), advanced curriculum intelligent embedded systems, 2nd or 3rd semester • Master Computer Science 2012 (optional subject), advanced curriculum intelligent embedded systems, 2nd or 3rd semester • 55 Hours private studies • Selected Topics of Signal Analysis and Enhancement (lecture, 2 • 55 Hours private studies			
 Selected Topics of Signal Analysis an 1 SWS) 	d Enhancement (exercise,	• 20 Hours exam p	reparation
 Contents of teaching: Introduction to statistical signal analysis Autocorrelation and spectral estimation Linear estimators Linear optimal filters Adaptive filters Multichannel signal processing, beamforming, and source separation Compressed sensing Basic concepts of multirate signal processing Nonlinear signal processing algorithms Application scenarios in auditory technology, enhancement, and restauration of one- and higher-dimensional signals, Sound-field measurement, noise reduction, deconvolution (listening-room compensation), inpainting 			
 Qualification-goals/Competencies: Students are able to explain the basic elements of stochastic signal processing and optimum filtering. They are able to describe and apply linear estimation theory. Students are able to describe the concepts of adaptive signal processing. They are able to describe and apply the concepts of multichannel signal processing. They are able to describe the concept of compressed sensing. They are able to analyze and design multirate systems. Students are able to explain various applications of nonlinear and adaptive signal processing. They are able to create and implement linear optimum filters and nonlinear signal enhancement techniques on their own. 			
Grading through:Written or oral exam as announced by the examiner			
Responsible for this module: • Prof. DrIng. Markus Kallinger Teacher: • Institute for Signal Processing • Prof. DrIng. Markus Kallinger Literature:			



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

Language:

• German and English skills required

Notes:

Prerequisites for attending the module:

- None

Prerequisites for the exam:

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

Modul exam:

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



	CS5280 - Seminar Robotics an	d Automation (SemRobAuto)
Duration:	Turnus of offer:	Credit points:
1 Semester	irregularly	4 (Тур В)
Course of study, specific field a • Master Computer Science	and term: e 2012 (optional subject), specialization	field robotics and automation, 3rd semester
Classes and lectures: • Advanced Seminar Robo	itics and Automation (seminar, 2 SWS)	 Workload: 90 Hours work on an individual topic with written and oral presentation 30 Hours in-classroom work
Contents of teaching: • Different topics from the • The students learn the conself-contained writing ar	e fields of robotics and artificial intelliger orrect reading of scientific papers, resea nd presentation of their own scientific el	nce for term papers are offered. rch and investigation, correct quotation and structuring, and laboration as a preparation for their final examination.
Qualification-goals/Competen The participants are able The students are able to The participants can ana present their own scient	rcies: to do research on scientific publication investigate self-dependently scientific p lyze and reproduce the tenor with rega- ific work.	is, to analyze the contents and to understand them. Sublications, to analyze and understand their contents. rd to their scope of work. The students are competent to write and
Grading through: • presentation		
Responsible for this module: Prof. DrIng. Achim Schw Prof. DrIng. Mladen Bere Teacher: Institute for Robotics and Institute of Computer En Prof. DrIng. Mladen Bere Prof. DrIng. Achim Schw	veikard ekovic d Cognitive Systems gineering ekovic veikard	
Language: • German and English skill	s required	



CS5295-KP04 - Project Robotics and Automation (PrRobAuto)			
Duration:	Turnus of offer:	Credit points:	
1 Semester	each winter semester	4 (Тур В)	
Course of study, specific field • Master Computer Scient • Master Computer Scient	and term: ce 2014 (compulsory), specialization fie ce 2012 (compulsory), specialization fie	ld robotics and automation, 2nd or 3rd semester ld robotics and automation, 3rd semester	
Classes and lectures:		Workload:	
 Project Robotics and Automation (practical course, 3 SWS) 		 45 Hours group work 45 Hours in-classroom work 30 Hours private studies 	
Contents of teaching:			
 Combination of robotic Introduction to / advance Realization of different Perception of objects at Collision detection Lokalization and Mappi Path planning Machine Vision Implementation of safe Programming of a Grap 	s and navigation ced project management robotic tasks in virtual and real environ nd advanced sensoring tasks ng ty functions hical User Interface (GUI)	ment	
 The students are able They have gained / interwith robotics and navig They are able to realize They can work as a tear They have experience in They can document and 	nsified their mathematical skills concer ation. complex processes with real time requ n and are able to manage the project a n the areas of usability and safety. d present their projects results.	ning e.g. localization and mapping and path planning in combination ests. nd to the realization in accordance with predefined milestones.	
Grading through: • documentation			
Requires: • Mobile Robots (CS2110- • Lab Course Robotics and • Robotics (CS2500-KP04,	KP04, CS2110) d Automation (CS3501-KP04, CS3501) CS2500)		
Responsible for this module: • Prof. DrIng. Achim Sch Teacher: • Institute for Electrical Er • Institute for Robotics an • Institute of Computer Er • Prof. DrIng. Mladen Be • Prof. DrIng. Achim Sch	weikard ngineering in Medicine d Cognitive Systems ngineering rekovic weikard		
 Prof. Dr. Philipp Rostals Literature: Jazar: Theory of applied 	ki Robotics: Kinematics, Dynamics and Co	ontrol	
 Spong et al: Robot Mod Siegwart et al : Autopor 	eling and Control - Wiley & Sons, 2005		

• Siegwart et.al.: Autonomous Mobile Robots - MIT Press 2011



Thrun et.al.: Probablistic Robotics - MIT Press 2005

Language:

• offered only in German

Othered only in German

 Notes:
 Admission requirements for taking the module:

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- None (the competencies of the modules listed under



CS5410-KP04 - Artificial Life (ArtiLife)			
Duration:	Turnus of offer:		Credit points:
1 Semester	irregularly		4
 Course of study, specific field and term: Master Biophysics 2019 (optional subject), Elective, 1st or 2nd semester Master CLS 2010 (optional subject), computer science, Arbitrary semester Master CLS 2010 (optional subject), life sciences, Arbitrary semester Master Computer Science 2012 (optional subject), specialization field robotics and automation, 3rd semester Master Computer Science 2012 (optional subject), specialization field bioinformatics, 3rd semester 			
Classes and lectures:		Workload:	
 Artificial Life (lecture, 2 SWS) Artificial Life (exercise, 1 SWS) 		 60 Hours private 45 Hours in-class 15 Hours exam p 	studies proom work preparation
Contents of teaching:			
 Properties, flavors and kinds of (artificial) life Artificial chemistry and self-replicating code Introduction to information theory Introduction to statistical mechanics and thermodynamics Complex networks and NK models Evolutionary algorithms Emergence Cellular automata Game of life Tierra Ant algorithms 			
 Students are able to classify models of artificial file, artificial chemistry and self-replicating code. Students have the competence to explain the mathematical concepts of information theory. Students are able to implement and mathematically analyze cellular automata and complex networks. Students can formulate mutualistic interactions through Boolean networks and game-theoretic models and can relate them to biological or socioeconomic systems. Students have the methodogical competence to design evolutionary algorithms and to review them in the context of statistical mechanics and thermodynamics. 			
Grading through: • Written or oral exam as announced by the examiner			
Responsible for this module: • PD Dr. rer. nat. Jens Christian Claussen Teacher: • Institute for Neuro- and Bioinformatics • Prof. Dr. rer. nat. Thomas Martinetz • PD Dr. rer. nat. Jens Christian Claussen			
Literature: • Christoph Adami: Introduction to Artificial Life - Springer Verlag, 1998			
Language: • English, except in case of only Germa	an-speaking participants		
Notes:			



Prerequisites for attending the module: - None

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



CS5420 - Fuzzy and Neuro-Fuzzy Systems (FuzzySys)		
Duration:	Turnus of offer:	Credit points:
1 Semester	I Semester not available anymore 4	
Course of study, specific field • Master Computer Scier • Master Computer Scier • Master Computer Scier	d and term: nce 2012 (optional subject), advanced nce 2012 (optional subject), specializa nce 2012 (optional subject), specializa	curriculum intelligent embedded systems, 2nd or 3rd semester tion field robotics and automation, 3rd semester tion field bioinformatics, 3rd semester
Classes and lectures:Workload:• Fuzzy and Neuro-Fuzzy Systems (lecture, 2 SWS)• 55 Hours private studies• Fuzzy and Neuro-Fuzzy Systems (exercise, 1 SWS)• 45 Hours in-classroom work• 20 Hours exam preparation		
Contents of teaching: Introduction Fuzzy sets Operations on fuzzy set Further concepts of fuz Approximative inference Fuzzy sytems Application classes of f Design and Implement Neuro-fuzzy systems	ts rzy sets ce uzzy systems ration of fuzzy systems	
Qualification-goals/Compete • Students are well acqu • They are able to critica • They can design fuzzy	Encies: ainted with the theoretical foundatio Ily judge the potential of these methe and neuro-fuzzy systems for suitable	ns and methods for fuzzy and neuro-fuzzy systems ods for various application areas applications and implement them in real systems
Grading through: • written exam		
Responsible for this modules • Prof. DrIng. Mladen Bo Teacher: • Institute of Computer E • Prof. DrIng. Mladen Bo	erekovic Engineering erekovic	
Literature: • : • : • : • : • :		
Language: • offered only in German	ı	



CS5430 - Seminar Machine Learning (SemMaschL)			
Duration:	Turnus of offer:	Credit points:	
1 Semester	each semester	4	
Course of study, specific field and • Master CLS 2010 (optional so • Master Computer Science 20 • Master Computer Science 20	l term: ubject), computer science, Arbitr D12 (optional subject), specializat D12 (optional subject), specializat	ary semester ion field robotics and automation, 3rd semester ion field bioinformatics, 3rd semester	
Classes and lectures: • Seminar Machine Learning (seminar, 2 SWS)		 Workload: 70 Hours private studies 30 Hours in-classroom work 20 Hours work on an individual topic with written and oral presentation 	
Contents of teaching: • Independent study of a spec	cific field of machine learning		
Qualification-goals/Competencies • The students are able to rea • They are able to present ora	s: d and understand scientific publ Illy and in a written paper the co	ications in the field of machine learning. ntent of scientific publications in the field of machine learning.	
Grading through: • term paper			
Responsible for this module: • Prof. Dr. rer. nat. Thomas Ma Teacher: • Institute for Neuro- and Bioir • Prof. Dr. rer. nat. Thomas Ma • Prof. DrIng. Erhardt Barth • MitarbeiterInnen des Institu	nrtinetz nformatics nrtinetz uts		
Language: • German and English skills re	quired		
Notes: Prerequisites for attending the - None	e module:		
Prerequisites for the exam: - Successful completion of hor	nework assignments during the	semester.	



CS5450-KP04, CS5450 - Machine Learning (MaschLern)			
Duration:	Turnus of offer:		Credit points:
1 Semester	each winter semester		4
Course of study, specific field and term: Master CLS 2023 (optional subject), Master Auditory Technology 2022 (c) Master MES 2020 (optional subject), Master Media Informatics 2020 (opti- Master Medical Informatics 2019 (opti- Master Auditory Technology 2017 (c) Master Auditory Technology 2017 (c) Master CLS 2016 (optional subject), Master MES 2014 (optional subject), Master MES 2011 (optional subject), Master MES 2011 (advanced curricu) Master Medical Informatics 2014 (optional subject), Master CLS 2010 (optional subject), c) Master Computer Science 2012 (opti- Master Curricu)	computer science, 3rd seme optional subject), computer computer science / electric onal subject), computer sci otional subject), Medical Dar optional subject), Medical Dar computer science, 3rd seme computer science, 3rd seme computer science / electric mathematics, 1st or 2nd se lum), imaging systems, sign otional subject), computer s omputer science, Arbitrary s ional subject), specialization ional subject), specialization	ester science, 1st semester sal engineering, Arbitrary se ence, Arbitrary semester ta Science / Artificial Intellig science, 1st semester ester sal engineering, Arbitrary se mester al and image processing, 1 cience, 1st or 2nd semeste semester n field robotics and automa n field bioinformatics, 3rd s	emester gence, 1st or 2nd semester emester lst or 2nd semester r ation, 3rd semester semester
Classes and lectures:		Workload:	
 Machine Learning (lecture, 2 SWS) Machine Learning (exercise, 1 SWS) 		55 Hours private45 Hours in-class20 Hours exam p	studies sroom work preparation
 Representation learning, including i Statistical learning theory VC dimension and support vector m Boosting Deep learning Limits of induction and importance 	nanifold learning nachines of data ponderation		
Qualification-goals/Competencies: Students can understand and expla They can explain and apply differen They can chose and then evaluate a They can understand and explain the comparison of the provides the provides the provides of the provides the provides of the pr	in various machine-learning t machine learning method n appropriate method for a e limits of automatic data a) problems. Is and algorithms. I particular learning proble Inalysis.	m.
Oral examination			
Responsible for this module: • Prof. DrIng. Erhardt Barth Teacher: • Institute for Neuro- and Bioinformatics • Prof. DrIng. Erhardt Barth • Prof. DrIng. Erhardt Barth • Prof. Dr. rer. nat. Thomas Martinetz			
Literature: • Chris Bishop: Pattern Recognition and • Vladimir Vapnik: Statistical Learning	nd Machine Learning - Sprir Theory - Wiley-Interscience	nger ISBN 0-387-31073-8 2, ISBN 0471030031	
English, except in case of only Germ	an-speaking participants		



Notes:

Admission requirements for taking the module:

- None

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

Module exam(s):

- CS5450-L1: Machine Learning, oral examination, 100% of module grade





	CS4440-KP04, CS4440 - Mole	cular Bioinformati	cs (MolBioInfo)
Duration:	Turnus of offer:		Credit points:
1 Semester	each winter semester		4
Course of study, specific field a Master CLS 2023 (optional Master Molecular Life Sci Master CLS 2016 (optional Master MES 2011 (advanal Master CLS 2010 (optional Master CLS 2010 (optional	and term: al subject), computer science, 3rd set ence 2023 (optional subject), mather al subject), computer science, 3rd set ced curriculum), biophysics and bion al subject), computer science, 1st or e 2012 (compulsory), specialization fi	mester matics / computer scier mester nedical optics, 2nd sem 3rd semester ield bioinformatics, 1st	ice, 1st semester ester semester
Classes and lectures:		Workload:	
 Molecular Bioinformatics (lecture, 2 SWS) Molecular Bioinformatics (exercise, 1 SWS) 		 55 Hours private studies 45 Hours in-classroom work 20 Hours exam preparation 	
Contents of teaching:			
 Methods for fast genome Analysis of data describin Advanced usage of biolo 	e comparison ng gene expression profiles and sequ gical databases (for sequences, moti	uence variation ifs, structures, gene reg	ulation and interactions)
Qualification-goals/Competen	cies:		
 The students can apply in They can use and design They are able to detect s 	ndexing based software to Next Gen databases for molecularbiological re tatistically significant changes in Mic	eration sequence data. esearch. croarray data.	
Grading through: • written exam			
Requires: • Introduction to Bioinforn	natics (CS1400-KP04, CS1400)		
Responsible for this module:			
• Prof. Dr. rer. nat. Thomas	Martinetz		
Teacher:			
 Institute for Neuro- and E 	Bioinformatics		
 Prof. Dr. Bernhard Haubo Prof. Dr. rer. nat. Thomas MitarbeiterInnen des Ins Prof. Lars Bertram 	ld Martinetz stituts		
Literature:			
 M. S. Waterman: Introduce B. Haubold, T. Wiehe: Int R. Durbin, S. Eddy, A. Kropress J. Setubal, J. Meidanis: In D. M. Mount: Bioinformatic 	ction to Computational Biology - Lor roduction to Computational Biology gh, G. Mitchison: Biological sequence troduction to computational molecu tics - Sequence and Genome - New Y	ndon: Chapman and Ha - Birkhäuser 2007 e analysis. Probabilistic ılar - Pacific Grove: PWS York: Cold Spring Harbo	l 1995 models - Cambridge, MA: Cambridge University Publishing Company r Press
Language:			
English, except in case of	only German-speaking participants		
Notes:			



Prerequisites for the module: - None

Prerequisites for admission to the written examination:

- Successful completion of exercises as specified at the beginning of the semester

Module exam(s):

- CS4440-L1: Molecular Bioinformatics, written exam, 90 min, 100 % of module grade



CS5440-KP04, CS5440 - Seminar Neuro- and Bioinformatics (SemNeurBio)			
Duration: Turnus of offer: Credit points:		Credit points:	
1 Semester	irregularly	4	
Course of study, specific field and • Master Biophysics 2019 (opti • Master Computer Science 20 • Master CLS 2010 (optional su	term: onal subject), Elective, 1st or 2n 12 (optional subject), specializat Ibject), computer science, Arbitr	d semester :ion field bioinformatics, 3rd semester ary semester	
Classes and lectures: Seminar Neuro- and Bioinformatics (seminar, 2 SWS) 		 Workload: 70 Hours private studies 30 Hours in-classroom work 20 Hours work on an individual topic with written and oral presentation 	
Contents of teaching: • Introduce students to a curre	ent research topic in Neuro- and	Bioinformatics	
Qualification-goals/Competencies The students are able to read They are able to present oral They can master basic scient They can summarize a scient They can give an intelligible They have communication communicat	: d and understand scientific publ ly and in a written paper the co ific methodology. :ific topic in written form. and concise oral presentation o ompetency to discuss a current	ications in the field of neuro- uand bioinformatics. ntent of scientific publications in the field of neuro- and bioinformatics. f a current research topic. research topic.	
Grading through: • oral presentation • term paper			
Responsible for this module: • Prof. DrIng. Erhardt Barth • Prof. Dr. rer. nat. Thomas Mar Teacher: • Institute for Neuro- and Bioir • Prof. Dr. rer. nat. Thomas Mar • Prof. DrIng. Erhardt Barth • MitarbeiterInnen des Institu	rtinetz nformatics rtinetz ıts		
Language: • English, except in case of onl	y German-speaking participants	;	
Notes: Prerequisites for attending the - None	module:		





CS5549-KP04 - Project Bioinformatics (PrBioinfo)			
Duration:	Turnus of offer:	Credit points:	
1 Semester	each winter semester	4 (Тур В)	
Course of study, specific field a • Master Computer Science • Master Computer Science	nd term: 2014 (compulsory), specialization f 2012 (compulsory), specialization f	ield bioinformatics, 1st, 2nd, or 3rd semester ield bioinformatics, 3rd semester	
Classes and lectures: Projektpraktikum Bioinformatik (practical course, 3 SWS) 		 Workload: 45 Hours private studies 45 Hours in-classroom work 30 Hours group work 	
Contents of teaching: • Project for solving a mole • Project for implementing	cular biology problem with comput biological information principles in	ational methods technical systems	
Qualification-goals/Competenc • The students can plan a p • They can apply bioinform • They are able to implement	ies: roject and realize in a team and wit atics software. nt learning algorithms.	h milestones.	
Grading through: • continuous, successful particular	ticipation in practical course, >80%)	
Responsible for this module: • Prof. Dr. rer. nat. Thomas N Teacher: • Institute for Neuro- and Bi • Prof. Dr. rer. nat. Thomas N • Prof. DrIng. Erhardt Barth • Prof. Dr. Bernhard Haubole • MitarbeiterInnen des Inst	Martinetz oinformatics Martinetz 1 d tituts		
Language: • German and English skills	required		


	LS2000-INF/MIW - B	iochemistry 1 (Bioch1)
Duration:	Turnus of offer:		Credit points:
1 Semester	each winter semester		4
Course of study, specific field and term: • Bachelor MES 2011 (optional subject • Master Computer Science 2012 (opti	t), life sciences, 5th semest ional subject), specializatio	er n field bioinformatics, 3rd s	emester
Classes and lectures: • Biochemie 1 (lecture, 3 SWS)	Workload: • 55 Hours in-class • 45 Hours private • 20 Hours exam p		room work studies reparation
Contents of teaching: Grundeigenschaften von Biosystemen, Biomoleküle Proteine: Struktur und Dynamik Enzyme: Struktur, Funktion, Regulation Intermediärstoffwechsel Biomembranen und Zellatmung 			
 Qualification-goals/Competencies: Verständnis der Strukturen und Funktion grundlegender Biomoleküle Verständnis der biochemischen Zusammenhänge und ihrer Bedeutung für den zellulären Stoffwechsel zu verstehen Vermittlung der Prinzipien biochemischer Trenn- und Analyseverfahren 			Stoffwechsel zu verstehen
Grading through: • written exam			
Responsible for this module: • Prof. Dr. rer. nat. Rolf Hilgenfeld Teacher: • Institute of Biochemistry • Prof. Dr. rer. nat. Rolf Hilgenfeld • Prof. Dr. rer. nat. Stefan Anemüller • Dr. math. et dis. nat. Jeroen Mesters			
Literature: • :			
Language: • offered only in English			



L	.53151-KP04, L53151 - Mo	ecular Biology (MolBioINF)	
Duration:	Turnus of offer:	Credit	points:
1 Semester	not available anymore	4	
Course of study, specific field and to Master Computer Science 2019 Master Computer Science 2019 Master Medical Informatics 201 Master Computer Science 2014 Master Medical Informatics 201 Master Computer Science 2012	erm: 9 (compulsory), Canonical Special 9 (optional subject), Elective, Arbit 19 (optional subject), bioinformat 4 (compulsory), specialization field 14 (optional subject), bioinformat 2 (compulsory), specialization field	zation Bioinformatics and Systems rary semester cs, 1st or 2nd semester bioinformatics, 1st, 2nd, or 3rd set cs, 1st or 2nd semester bioinformatics, 2nd semester	Biology, Arbitrary semester mester
Classes and lectures:		Workload:	
 Molecular Biology (lecture, 2 S Molecular Biology (seminar, 2 	WS) SWS)	60 Hours private studies60 Hours in-classroom wo	ork
 Contents of teaching: Lecture: Molecular basis for processing and analysis of biological data (nucleic acids, genome sequencing, DNA polymorphism, infection biology, host genome and virus infection, stem cell biology) Seminar: Scientific article reading and oral presentation understanding scientific context training in reading English in science 			
Qualification-goals/Competencies:			
 Students are able to present b They are able to explain the m They acquire the competence 	asic molecular biological requirer olecular biological terms genome to handle English literature and t	nents for processing and analysis o , transcriptome and proteome. o present it in a scientific oral prese	f biological data. entation.
Grading through: • Oral examination			
Responsible for this module: Prof. Dr. rer. nat. Norbert Tautz Teacher: Institute of Virology and Cell B Dr. rer. nat. Olaf Isken 	iology		
Prof. Dr. rer. nat. Norbert Tautz	:		
Literature: • Alberts et al.: Molecular Biolog • Lodish et al.: Molecular Cell Bio	y of Cells - Garland Science blogy - Freeman		
Language: • offered only in German			
Notes: Seminar-dates by appointment, Prerequisites for attending the m - None Prerequisites for the exam: - attendance, >90%	prior registration is mandatory nodule:		



MA1600-KP04, MA1600, MA1600-MML - Biostatistics 1 (BioStat1)			
Duration:	Turnus of offer:		Credit points:
1 Semester	each summer semester		4
Course of study, specific field and term: Bachelor CLS 2023 (compulsory), mathematics, 2nd semester Bachelor Nutritional Medicine 2024 (compulsory), mathematics / natural sciences, 4th semester Bachelor Nutritional Medicine 2024 (compulsory), mathematics / natural sciences, 4th semester Bachelor MES 2014 (optional subject), Extended optional subject, Arbitrary semester Bachelor Medical Informatics 2019 (optional subject), Extended optional subjects, Arbitrary semester Bachelor Medical Informatics 2019 (compulsory), mathematics / computer science, 6th semester Bachelor Medical Informatics 2019 (compulsory), mathematics / computer science, 6th semester Bachelor Nutritional Medicine 2018 (compulsory), mathematics / computer science, 6th semester Bachelor Nutritional Medicine 2016 (compulsory), mathematics / computer science, 6th semester Bachelor CLS 2016 (compulsory), mathematics, 2nd semester Bachelor CLS 2016 (compulsory), Elective Computer Science, 6th semester Bachelor ClS 2016 (compulsory), Elective Computer Science, 4th semester Bachelor Science 2016 (compulsory), mathematics / computer science, 6th semester Bachelor Science 2016 (compulsory), mathematics / computer science, 6th semester Bachelor Nutritional Medicine 2016 (compulsory), mathematics / computer science, 6th semester Bachelor Science 2014 (compulsory), mathematics / computer science, 6th semester Bachelor Science 2014 (compulsory), mathematics / computer science, 6th semester Bachelor Science 2014 (compulsory), mathematics / computer science, 6th semester Bachelor Mutritional Medicine 2016 (compulsory), mathematics / computer science, 6th semester Bachelor Computer Science 2014 (compulsory), mathematics / computer science, 6th semester Bachelor Computer Scienc			ester earliest semester d Systems Biology, 6th semester mester ter th semester mester nester nester nester
Classes and lectures: • Biostatistics 1 (lecture, 2 SWS)		Workload: • 66 Hours private	studies
Biostatistics 1 (exercise, 1 SWS)		 39 Hours in-class 15 Hours exam p	room work reparation
Contents of teaching: Descriptive statistics Probability theory, including random variables, density, and cumulative distribution function Normal distribution, other distributions Diagnostic tests, reference range, normal range, coefficient of variation Statistical testing Sample size calculations Confidence intervals Selected statistical tests I Selected statistical tests I Linear simple regression Analysis of variance (one-way-classification) Clinical trials Multiple Testing: Bonferroni, Bonferroni-Holm, Bonferroni-Holm-Shaffer, Wiens, hierarchical Testing			
 Qualification-goals/Competencies: With regard to the roles of GSP of the University of Lübeck and of the DFG-guidelines the student were able to work with the following statistical methods: The students are able to calculate descriptive statistics. They are able to calculate quantiles and surfaces of the normal distribution. They are able to explain terms of diagnostic testing, such as sensitivity or specificity. 			

• They are able to list the basic principles of statistical testing, sample size calculation and confidence interval construction.



the results.	
 They are able to explain the basic principles of linear regression. 	
 They are able to apply the linear simple regression. 	
• They are able to explain the basic idea for the one-way analysis of variance (ANOVA).	
• They are able to explain the results table for the one-way and two-way ANOVA.	
• They are able to interpret the results of the ANOVA.	
Ihey know the basic principles of clinical therapeutic studies.	
 They know the assumptions that need to be fulfilled for the application of specific statistical tests. They are able to calculate simple adjustments for multiple comparisons. 	
Grading through:	
written exam	
s requisite for:	
Module part: Biostatistics 2 (MA2600 T)	
• Biostatistics 2 (MA2600-KP07)	
Biostatistics 2 (MA2600-KP04, MA2600)	
Responsible for this module:	
Prof. Dr. rer. biol. hum. Inke König	
Geacher.	
Institute of Modical Piemetry and Statistics	
Institute of Medical Biometry and Statistics	
Prof. Dr. rer. biol. hum. Inke König	
MitarbeiterInnen des Instituts	
itoraturo	
Menthies Dudelf William d Kuhlisch, Disstatistik Firs Finführung für Dissuissenschaftlag, 1. Auflagt Dessen Deutschland	
 Matthias Rudolf, Wiltrud Ruhlisch: Biostatistik: Eine Einfuhrung für Biowissenschaftler - T. Auflage, Pearson: Deutschland Lothar Sachs, Jürgen Hedderich: Angewandte Statistik: Methodensammlung mit R - 15. Auflage, Springer: Heidelberg 	
-anguage.	
offered only in German	
Notes:	
Prerequisites for attending the module:	
- None	
Prerequisites for the exam:	
- Active and regular participation in the exercise groups as specified at the beginning of the semester.	
Module exam:	
-MA1600-L1: Biostatistics 1, written exam, 90 min, 100 % of module grade	

• They are able to carry out a set of elementary statistical tests, such as t-test, test of proportions, X2 independence test, and to interpret



	MA4020-KP04, MA402	0 - Stochastics 2	(Stoch2)	
Duration:	Turnus of offer:		Credit points:	
1 Semester	each winter semester		4	
Course of study, specific field an Master Biophysics 2019 (op Master MES 2011 (optional Master Computer Science 2 Master Computer Science 2 Master Computer Science 2 Bachelor MES 2011 (option	d term: otional subject), Elective, 1st semest subject), mathematics, 1st semeste 2012 (optional subject), specializatic 2012 (compulsory), advanced currice 2012 (optional subject), advanced cur al subject), mathematics, 5th semes	er er on field bioinformatics ulum stochastics, 3rd urriculum analysis, 3rd ster	, 3rd semester semester I semester	
Classes and lectures:		Workload:		
 Stochastics 2 (lecture, 2 SW Stochastics 2 (exercise, 1 Stochastics 2) 	 Stochastics 2 (lecture, 2 SWS) Stochastics 2 (exercise, 1 SWS) Stochastics 2 (exercise, 1 SWS) 65 Hours private studies and exercises 45 Hours in-classroom work 10 Hours exam preparation 		rivate studies and exercises n-classroom work xam preparation	
 Lebesgue integral and Rier Transformations of measur Product measures and Fub Moments and dependency Normally distributed rando 	nann integral res and integrals ini's theorem r measures om vectors and distributions closely	related to the norma	distribution	
Qualification-goals/Competenci • Studends get insights into • They master techniques of • They master the treatment • They are able to formalize	es: basic stochastic structures integration being relevant to stoch of (particularly normally distributed complex stochastic problems	nastics d) random vectors and	their distributions	
Grading through: • written exam • Exercises				
Is requisite for: • Modeling Biological Systen • Stochastic processes and n	ns (MA4450) nodeling (MA4610-KP04, MA4610)			
Requires: • Stochastics 1 (MA2510-KPC • Linear Algebra and Discret • Analysis 2 (MA2500-KP04, J	4, MA2510) e Structures 2 (MA1500-KP08, MA15 MA2500)	500)		
Responsible for this module: • Nachfolge von Prof. Dr. rer. Teacher: • Institute for Mathematics • Nachfolge von Prof. Dr. rer.	nat. Karsten Keller nat. Karsten Keller			
Literature: • J. Elstrodt: Maß- und Integ • M. Fisz: Wahrscheinlichkeit	rationstheorie - Springer srechnung und mathematische Stat	tistik - Deutscher Verl	ag der Wissenschaften	
Language: • offered only in German				



Notes:

The lecture is identical to that in module MA4020-MML.

Prerequisites for attending the module: - None

Prerequisites for the exam:

- Successful completion of homework assignments during the semester.



MA4400 - Chaos and Complexity of Biological Systems (CKBS)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	irregularly		4	
 Course of study, specific field and term: Bachelor CLS 2010 (optional subject), mathematics, 5th or 6th semester Master MES 2011 (optional subject), mathematics, 1st or 2nd semester Master Computer Science 2012 (optional subject), specialization field bioinformatics, 2nd or 3rd semester Master MES 2011 (advanced curriculum), biophysics and biomedical optics, 1st or 2nd semester Master CLS 2010 (optional subject), mathematics, Arbitrary semester 				
Classes and lectures:		Workload:		
 Chaos and Complexity of Biological Chaos and Complexity of Biological 	Systems (lecture, 2 SWS) Systems (exercise, 1 SWS)	 65 Hours private 45 Hours in-class 10 Hours exam p 	studies and exercises sroom work preparation	
Contents of teaching:				
 Time-discrete dynamical systems and stochastic processes Nonlinearity and chaos Ergodicity Symbolic dynamics Information-theoretic complexity measures Ordinal time series analysis Biological and medical applications in particular EEG analysis 				
 Qualification-goals/Competencies: Students get insights into basic aspective of the state o	 Qualification-goals/Competencies: Students get insights into basic aspects of nonlinear dynamics They have skills in analyzing and modeling complex data and time series They have competencies in simulating and illustrating nonlinear dynamic phenomena 			
Grading through: • Written or oral exam as announced	by the examiner			
Requires: • Stochastics 1 (MA2510-KP04, MA2510) • Analysis 1 (MA2000-KP08, MA2000)				
Responsible for this module:				
Nachfolge von Prof. Dr. rer. nat. Kars	ten Keller			
Teacher:				
Institute for Mathematics				
Nachfolge von Prof. Dr. rer. nat. Kars	ten Keller			
 Literature: M. Brin, G. Stuck: Introduction to Dynamical Systems - Cambridge University Press 2002 J. M. Amigó: Permutation Complexity in Dynamical Systems - Springer 2010 R. L. Devaney: An Introduction to Chaotic Dynamical Systems - Westview Press 2003 				
Language:	l anguage:			
 depends on the chosen courses 	depends on the chosen courses			
Notes: lecture notes in English Prerequisite tasks for taking the exam can be announced at the beginning of the semester. If any prerequisite tasks are defined, they				



must be completed and passed before taking the exam for the first time.





	MA4450 - Modeling Bi	ological Systems (MoBS)
Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4
Course of study, specific field • Master MES 2011 (optic • Master MES 2011 (adva • Master Computer Scien • Master Computer Scien	J and term: onal subject), mathematics, 1st semeste nced curriculum), biophysics and biom nce 2012 (compulsory), specialization fie nce 2012 (optional subject), advanced cu	r edical optics, 1st semester Id bioinformatics, 1st semester urriculum organic computing, 2nd or 3rd semester
Classes and lectures:		Workload:
 Modeling Biological System Modeling Biological System 	stems (lecture, 2 SWS) stems (exercise, 1 SWS)	 65 Hours private studies and exercises 45 Hours in-classroom work 10 Hours exam preparation
Contents of teaching:		
 Elementary time-discree Structured time-discret Generating functions, C Modeling of data and c 	te deterministic models se population dynamics Galton-Watson-processes lata analysis	
Oualification-goals/Compete	ncies:	
 Students have knowled They develop skills in c They have competencie They develop compete 	lge of elementary time-discrete models onnecting ideas from different fields of es in data analysis and modelling ncies in interdisciplinary work	for modeling biological processes mathematics
Grading through: • Exercises • written exam		
Poquiros:		
 Stochastics 1 (MA2510- Analysis 2 (MA2500-KP) Linear Algebra and Disc 	KP04, MA2510) 04, MA2500) crete Structures 2 (MA1500-KP08, MA15	00)
Responsible for this module:		
Nachfolge von Prof. Dr.	rer. nat. Karsten Keller	
Teacher:		
 Institute for Mathemati 	CS	
Nachfolge von Prof. Dr.	rer. nat. Karsten Keller	
Literature:		
 F. Braer, C. Castillo-Cha H. Caswell: Matrix Popu S. N. Elaydi: An Introduce B. Huppert: Angewand U. Krengel: Einführung E. Seneta: Non-negative 	vez: Mathematical Models in Populatior Ilation Modells - Sunderland: Sinauer As ction to Difference Equations - New Yor te Lineare Algebra - Berlin: de Gruyter 1 in die Wahrscheinlichkeitstheorie und S e Matrices and Markov Chains - New Yo	ı Biology and Epidemiology - New York: Springer 2000 sociates 2001 k: Springer 1999 990 Statistik - Wiesbaden: Vieweg 2002 rk: Springer 1981
Language: • offered only in German		
Notes:		
The lecture is identical to	that in module MA4450-MML. For stud	ents in the master Infection Biology programme, this is not a stand-alone



module, but rather part of module CS4011.



CS3115-KP04, CS5156-KP04, CS5156 - System Architectures for Multimeda (SysArchMM)			
Duration:	Turnus of offer:		Credit points:
1 Semester	every summer semester		4
Course of study, specific field and term: Bachelor IT-Security 2016 (optional Bachelor Media Informatics 2020 (op Bachelor Computer Science 2019 (op Master Medical Informatics 2014 (opt Master Media Informatics 2014 (opt Master Computer Science 2012 (opt Master Computer Science 2012 (opt Master Computer Science 2012 (opt Master Computer Science 2012 (opt	subject), specific, Arbitrary se otional subject), computer se ptional subject), major subje otional subject), computer sci ional subject), computer sci ional subject), advanced cur ional subject), advanced curr ional subject), specialization	emester cience, 5th or 6th semeste ct informatics, Arbitrary se cience, 1st or 2nd semeste ence, Arbitrary semester riculum signal and image field software systems en iculum parallel and distrib field media informatics, 2	r emester r processing, 2nd or 3rd semester igineering, 3rd semester uted system architecutres, 2nd or 3rd semester 2nd or 3rd semester
Classes and lectures:		Workload:	
 System Architectures for Multimedia System Architectures for Multimedia 	a (lecture, 2 SWS) a (exercise, 1 SWS)	55 Hours private45 Hours in-class20 Hours exam p	studies sroom work preparation
Contents of teaching:			
 Instruction set extensions for x86 processors System architecture of game consoles and multimedia systems Hardware structures for the realization of basic image and video processing operations System integration of hardware accelerators Programming of multimedia applications with OpenGL Protection and authentication of multimedia data Qualification-goals/Competencies: Students are able to categorize instruction set extensions of processors for multimedia applications. They are able to discuss the characteristics of the system structure of game consoles and multimedia systems. They are able to evaluate the usefulness of specific processor architectures and system structures for the realization of multimedia systems. They are able to determine appropriate hardware structures for the implementation of image and video processing algorithms. 			
Grading through:			
• see Notes			
Responsible for this module: • Prof. DrIng. Mladen Berekovic Teacher: • Institute of Computer Engineering • Prof. DrIng. Mladen Berekovic			
Literature:			
 P. A. Henning: Taschenbuch Multimedia - München: Fachbuchverlag Leipzig 2007 A. S. Tanenbaum: Moderne Betriebssysteme - München: Pearson 2009 D. G. Bailey: Design for Embedded Image Processing on FPGAs - Wiley & Sons 2011 D. Kusswurm: Modern x86 Assembly Language Programming - Apress 2015 A. Nischwitz, M. Fischer, P. Haberäcker, G. Socher: Computergrafik und Bildverarbeitung - Vieweg + Teubner, 2011 			
Language: • offered only in German			



Notes:

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- Successful completion of exercise assignments as specified at the beginning of the semester

Module Exam(s):

- CS3115-L1: System Architectures for Multimeda, oral exam, 100% of the module grade



CS3202-KP04, CS3202 - Nonstandard Database Systems (NDB)		
Duration:	Turnus of offer:	Credit points:
1 Semester	not available anymore	4
1 Semester not available anymore 4 Course of study, specific field and term: • Bachelor Medical Informatics 2014 (optional subject), computer science, 5th or 6th semester • Bachelor Computer Science 2014 (optional subject), computer science, 5th or 6th semester • Bachelor Medical Informatics 2011 (optional subject), computer science, 5th or 6th semester • Bachelor Medical Informatics 2011 (optional subject), computer science, 5th or 6th semester • Bachelor Medical Informatics 2011 (optional subject), acentral topics of computer science, 5th or 6th semester • Master Computer Science 2012 (optional subject), applied computer science, 4th to 6th semester • Master CLS 2010 (optional subject), computer science, Arbitrary semester • Bachelor Computer Science 2012 (optional subject), advanced curriculum distributed information systems, 2nd or 3rd semester • Master Computer Science 2012 (optional subject), central topics of computer science, 5th or 6th semester • Master Computer Science 2012 (optional subject), central topics of computer science, 5th or 6th semester • Master Computer Science 2012 (optional subject), central topics of computer science, 5th or 6th semester • Nonstandard Database Systems (lecture, 2 SWS) • 65 Hours private studies • Nonstandard Database Systems (exercise, 1 SWS) • 65 Hours private studies • 10 Hours exam preparation • 10 Hours exam preparation		
 Databases for data Databases for inco Probabilistic datab Databases with an 	a streams (window concept) Implete information (e.g., constraint databas Dases Iswer ranking (top-k queries)	es)
 Qualification-goals/Com Knowledge:Studer models emerge if explaining the ma techniques used for Skills:Students can sample datasets in relational data mo to or can be imple apply dedicated al showing how inde answers by evalua Social skills:Studer small presentation formalism present 	Ipetencies: Ints can name the main features of standard of features are dropped. They can describe the in features of respective query languages (sy or their practical realization. In apply query languages for non-standard da order to satisfy information needs specified idel using encoding techniques presented in remented in SQL (in particular, SQL-99). In case lgorithms for query answering. Students can ex structures are built, updated, and exploite- iting queries step by step and by deriving op ints work in teams to handle assignments, and is (in lab classes). In addition, self-dependence ared in the lecture such that students get family	latabases and, in addition, can explain which non-standard database main ideas behind non-standard databases presented in the course by ntax and semantics) as well as the most important implementation ta models introduced in the course to retrieve desired structures from textually in natural language. Students are able to represent data in the the course such that they can demonstrate how new formalisms relate an SQL transformation cannot be found, students can explain and demonstrate how index structures help answering queries fast by d for query answering. The participants of the course can derive query timized query execution plans. d they are encouraged to present their solution to other students in the is fostered by giving pointers to query evaluation engines for various liar with data models and query languages by self-controlled work.
Grading through: • Written or oral exa	im as announced by the examiner	
Requires: • Databases (CS2700	D-KP04, CS2700)	
Responsible for this mod • Prof. Dr. rer. nat. ha Teacher:	dule: abil. Ralf Möller	

Institute of Information Systems



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

Literature:

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

Language:

• offered only in German



CS415	5 - Communication Systems f	for Multimedia Appl	ications (KMA)	
Duration:	Turnus of offer:		Credit points:	
1 Semester	not available anymore		4	
Course of study, specific field and • Master Computer Science 20	l term: 012 (compulsory), specialization field	l media informatics, 2nd s	emester	
Classes and lectures: Workload: • Communication Systems for Multimedia Applications (lecture, 2 SWS) • 60 Hours prive • Communication Systems for Multimedia Applications (practical course, 1 SWS) • 15 Hours are		Workload: • 60 Hours private • 30 Hours in-class • 15 Hours exam p • 15 Hours group v	studies room work reparation vork	
Contents of teaching: • Media Compression (of Real-time Media) • Multimedia Operating Systems • Server and Databases for Multimedia • Media Transmission (Broadcast / Streaming) • Communication Protocols for Multimedia • Media Synchronisation and Adaptation • Quality of Service • Applications				
Qualification-goals/Competencies Participants know about the They know the foundationa For each of the components They are able to apply their	s: challenges of transmitting and proc l mechanism and techniques for the s they now the principal solutions to knowledge for building simple imple	cessing multimedia data ir provision and transmissio address the respective ch ementations.	n distributed computer systems. n of media. allenges.	
Grading through: • Written or oral exam as anno	ounced by the examiner			
Responsible for this module: • Prof. DrIng. Andreas Schrad Teacher: • Institute of Telematics • Prof. DrIng. Andreas Schrad	ler Jer			
Literature: • Ralf Steinmetz, Klara Nahrsto • Ralf Schmitz et al.: Kompenco • Stephen Weinstein: The Mul	edt: Multimedia Systems - Springer 2 Jium Medieninformatik: Mediennetze timedia Internet - Springer 2005	2004 e - Springer 2006		
• German and English skills required				
Notes: Dieses Modul wird durch das I	Nodul CS4555 Medienübertragung e	ersetzt.		



CS46	20 - Psychological Foundation	s of Media Informatics (PsyMedien)
Duration:	Turnus of offer:	Credit points:
1 Semester	not available anymore	4
Course of study, specific field a	and term:	
Master Computer Science	e 2012 (compulsory), specialization field	d media informatics, 1st semester
Classes and lectures: Wo • Psychological Foundations of Media Informatics (lecture with exercises, 4 SWS)		 Workload: 60 Hours in-classroom work 40 Hours private studies 20 Hours exam preparation
Contents of teaching: Introduction General methods of psychology Fundamentals of work psychology Fundamentals of media psychology Fundamentals of perception psychology Fundamentals of cognitive psychology Evaluation methods Summary 		
Qualification-goals/Competen • The students know the m • They are in able to work • They know the importan of multimedia and intera • They can collaborate effe Grading through:	cies: nethodology of psychology and can int with psychological methods, and to re- t findings of the work, media, perceptio ctive systems. ectively in interdisciplinary teams with p	egrate this in an interdisciplinary context in Media Informatics. ad and understand psychological studies. on and cognitive psychology, and are able to apply these in the context osychologists.
• written exam		
Responsible for this module: • Prof. Dr. rer. nat. Michael Teacher: • Institute for Multimedia a • Prof. Dr. rer. nat. Michael	Herczeg and Interactive Systems Herczeg	
Literature:		
 P.G. Zimbardo & R.J. Gerrig: Psychologie. Eine Einführung - München: Pearson, 2004 W. Edelmann: Lernpsychologie - Weinheim: Beltz Verlag, 2000 G. Bente, R. Mangold & P. Vorderer: Lehrbuch der Medienpsychologie - Göttingen: Hogrefe-Verlag, 2004 E. Ulich: Arbeitspsychologie - Stuttgart: Schäffer-Poeschel, 2005 N. Birbaumer & R.F. Schmidt: Biologische Psychologie - Berlin: Springer-Verlag, 2005 		chen: Pearson, 2004 ologie - Göttingen: Hogrefe-Verlag, 2004 pringer-Verlag, 2005
Language: • offered only in German		





CS4640-KP04 - Hypermediasystems (HyperMeSys)			
Duration:	Turnus of offer:		Credit points:
1 Semester	each winter semester		4
Course of study, specific fiel • Master Media Informat • Master Computer Scient	d and term: ics 2014 (compulsory), media informa nce 2012 (compulsory), specialization	tics, 1st semester field media informatics, 2nd s	emester
Classes and lectures: • Hyper Media Systems • Hyper Media Systems	Classes and lectures:Workload:• Hyper Media Systems (lecture, 2 SWS)• 55 Hours private studies• Hyper Media Systems (exercise, 1 SWS)• 45 Hours in-classroom work• 20 Hours exam preparation		studies room work reparation
Contents of teaching: Introduction and Overview History Navigation, Orientation and Search Semantic Web and Hypermedia Systems Applications and Examples Adaptability and adaptivity 			
 Qualification-goals/Competencies: Students know the definition and the theoretical foundations of hypermedia systems and can explain these. They are able to identify and predict the difficulties and potentials of hypermedia systems based on historical and technological considerations. They can analyze, design, implement and evaluate hypermedia applications considering users and context. 			can explain these. s based on historical and technological users and context.
Grading through: • written exam			
Responsible for this module: • Prof. Dr. rer. nat. Michael Herczeg Teacher: • Institute for Multimedia and Interactive Systems • Prof. Dr. rer. nat. Michael Herczeg			
Literature: • J. Nielsen: Multimedia, Hypertext und Internet - Wiesbaden: Vieweg, 1996 • R. Schulmeister: Grundlagen Hypermedialer Lernsysteme: Theorie, Didaktik, Design - München: Oldenbourg-Verlag, 2002			
offered only in German			



CS4650-KP04 - Augmented, Mixed and Virtual Reality (AMVReality)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	Semester each winter semester 4		4	
Course of study, specific field • Master Media Informatic • Master Computer Science	and term: ss 2014 (compulsory), computer scien se 2012 (compulsory), specialization f	ce, 3rd semester ield media informatics, 3rd se	emester	
Classes and lectures: • Augmented, Mixed and • Augmented, Mixed and	Classes and lectures:Workload:• Augmented, Mixed and Virtual Reality (lecture, 2 SWS)• 55 Hours private studies• Augmented, Mixed and Virtual Reality (exercise, 1 SWS)• 45 Hours in-classroom work• 20 Hours exam preparation			
Contents of teaching: Introduction and Overview Historical developments Applications of augmented, mixed and virtual reality (AMVR) Theoretical principles of AMVR Interaction models for AMVR Implementation of AMVR systems Evaluation of AMVR systems Looking into the future of AMVR 				
Qualification-goals/Competer • The students know the l • They are able to estimat • They understand the po	ncies: pasic principles and system models o e the effort for the development of t sitive and negative effects of such sy	f augmented, mixed and virt hese types of systems. stems.	ual reality.	
Grading through: • written exam				
Responsible for this module: Dr. Thomas Winkler Teacher: Institute for Multimedia and Interactive Systems Dr. Thomas Winkler 				
Literature: • Dörner; Broll; Grimm; Ju Augmentierten Realität	ng (Hrsg.): Virtual und Augmented Re - Springer Vieweg, 2014	eality (VR / AR): Grundlagen u	nd Methoden der Virtuellen und	
Language: • offered only in German				



	CS5155 - Mobile Multime	edia Systems (MobiMMSys)
Duration:	Turnus of offer:	Credit points:
1 Semester	not available anymore	4
Course of study, specific field • Master Computer Science	and term: ce 2012 (optional subject), specialization	on field media informatics, 2nd or 3rd semester
Classes and lectures:		Workload
Mobile Multimedia Systems (lecture, 2 SWS) Mobile Multimedia Systems (exercise, 1 SWS) Mobile Multimedia Systems (exercise, 1 SWS) Mobile Multimedia Systems (exercise, 1 SWS)		 60 Hours private studies 45 Hours in-classroom work 15 Hours exam preparation
Contents of teaching: Introduction Requirements of Mobile Mobile Devices Interaction with Mobile Mobile Multimedia App Mobile Multimedia Data Mobile Multimedia Soft Media Transport in Wire Operating Systems for r Development and Progr Digital Audio and Video Qualification-goals/Competen Students know about th Students know current for Students are able to imp	e Multimedia Systems Devices lications a Formats ware Systems eless Mobile Networks nobile Systems ramming for Android Broadcasting (DAB/DVB) ncies: ne main tasks and challenges of mobile technical solutions for the realisation o plement mobile multimedia application	e multimedia systems. f mobile multimedia systems. ns for mobile devices.
Grading through: • Oral examination		
Responsible for this module: • Prof. DrIng. Andreas Sc Teacher: • Institute of Telematics • Prof. DrIng. Andreas Sc	hrader hrader	
Literature: • Amitabh Kumar: Implen • Shelly Powers: HTML5 M • Shawn Van Every: Pro A 2010 • Roland Schmitz et al.: Ko • Diverse authors: Dedica	nenting Mobile TV - Focal Press 2010 Media - O'Reilly Media 2011 ndroid Media: Developing Graphics, M ompendium Medieninformatik: Medier ted Scientific Papers from relevant con	usic, Video, and Rich Media Apps for Smartphones and Tablets - Apress Inetze - Springer 2006 ferences - MobiMedia, MoMM, MuM, AmbiSys, etc.
German and English skil	ls required	



	CS5157 - Media Co	mpression (MedienKomp)
Duration:	Turnus of offer:	Credit points:
1 Semester	not available anymore	2 4
Course of study, specific field • Master Computer Scien	d and term: ace 2012 (optional subject), specializa	ition field media informatics, 2nd or 3rd semester
Classes and lectures:Workload:• Media Compression (lecture with exercises, 3 SWS)• 65 Hours private studies and exercises• 45 Hours in-classroom work• 10 Hours exam preparation		 Workload: 65 Hours private studies and exercises 45 Hours in-classroom work 10 Hours exam preparation
Contents of teaching: • • • • • •		
Qualification-goals/Compete • Verständnis der algorit • Kenntnis der aktuellen • Fähigkeit zur Beurteilun • Erkennen von Grenzen	encies: hmischen Grundlagen zur Kompressi Verfahren ng von Güte- und Sicherheitseigensc der Komprimierung	on digitaler Daten haften
Grading through: • Viva Voce or test		
Requires: • Algorithmics (CS4000)		
Responsible for this module: • Prof. Dr. Maciej Liskiew Teacher: • Institute for Theoretical • Prof. Dr. Maciej Liskiew	icz I Computer Science icz	
Literature: • : • : • : • : Language:		
English, except in case	of only German-speaking participant	S





CS5159 - Ubiquitous Computing (UbiqComp)					
Duration:	Turnus of offer:		Credit points:		
1 Semester	not available anymore		4		
Course of study, specific field and term • Master CLS 2010 (optional subject • Bachelor CLS 2010 (optional subje • Master Computer Science 2012 (o • Master Computer Science 2012 (o	:), mathematics, 2nd or 3rd ct), mathematics, 5th or 6t ptional subject), advanced ptional subject), specializat	semester h semester curriculum organic computi ion field media informatics,	ng, 2nd or 3rd semester 2nd or 3rd semester		
Classes and lectures:	Classes and lectures: Workload:				
Ubiquitous Computing (lecture wi	 Ubiquitous Computing (lecture with exercises, 3 SWS) 60 Hours private studies and exercises 45 Hours in-classroom work 15 Hours exam preparation 				
Contents of teaching: The Technology trends: information technology, new materials Wireless communication and mobile computing Spontaneous networking Context awareness: location, context, and situation Smart labels (RFIDs) and wireless chipcards Embedded systems and sensors Energy aspects Wearable computing Interaction with invisible computers Software infrastructures Selected research projects Applications scenarios 					
 Qualification-goals/Competencies: Understand fundamental challenges, concepts, approaches, and limitations of UC Follow and judge recent UC research papers Design, implementation, and analysis of exemplary UC systems 					
Responsible for this module: Prof. DrIng. Thilo Pionteck (Nacht Teacher: Institute of Computer Engineering Prof. DrIng. Thilo Pionteck (Nacht) 	folger NN) folger NN)				
Literature:					
 Friedemann Mattern (Ed.): Die Informatisierung des Alltags - Leben in smarten Umgebungen - Springer-Verlag, 2007 Elgar Fleisch, Friedemann Mattern (Eds.): Das Internet der Dinge - Ubiquitous Computing und RFID in der Praxis - Springer-Verlag, 2005 					
Language: • offered only in German					



	CS5210 - Electronic Bus	iness Processes (EGeschProz)		
Duration:	Turnus of offer:	Credit points:		
1 Semester	not available anymore	4		
Course of study, specific fie • Master Media Informa • Master Computer Scie	e ld and term: atics 2014 (optional subject), computer ence 2012 (optional subject), specializa	science, Arbitrary semester tion field media informatics, 2nd or 3rd semester		
 Classes and lectures: Electronic Business Processes (lecture, 2 SWS) Electronic Business Processes (practical course, 1 SWS) 		 Workload: 60 Hours private studies 30 Hours in-classroom work 15 Hours exam preparation 15 Hours group work 		
Qualification-goals/Compe	tencies:			
Grading through: • Oral examination				
Responsible for this modul • Prof. Dr. Stefan Fische Teacher: • Institute of Telematic	le: er S			
Language: • offered only in Germa	an			



CS5605 - Media Theory and Semiotics (MTheoSemio)				
Duration:	Turnus of offer:	Credit points:		
1 Semester	not available anymore	4		
Course of study, specific field and • Master Computer Science 2	l term: 012 (optional subject), specialization	n field media informatics, 2nd or 3rd semester		
Classes and lectures:		Workload:		
Medientheorie und Semiotik (lecture with exercises, 3 SWS) S5 Hours 45 Hours 20 Hours		 55 Hours private studies 45 Hours in-classroom work 20 Hours exam preparation 		
Contents of teaching: • • • • • • • • • • • • • • • • • • •				
Qualification-goals/Competencie • •	s:			
Grading through: • Written or oral exam as ann	ounced by the examiner			
Requires: • Human-Computer-Interaction	on (CS4230)			
Responsible for this module: • Dr. Thomas Winkler Teacher: • Institute for Multimedia and • Dr. Thomas Winkler Literature: • : • : • :	l Interactive Systems			
• . Language: • offered only in German				



CS5610-KP04, C	CS5610 - Computer-Suppo	rted Teaching and L	earning (CGLehrLern)
Duration:	Turnus of offer:		Credit points:
1 Semester	every summer semester		4
Course of study, specific field and te • Bachelor Media Informatics 20 • Bachelor Media Informatics 20 • Master Computer Science 2012	e rm: 20 (optional subject), media infor 14 (optional subject), computer so 2 (optional subject), specialization	matics, 5th or 6th semeste cience, 5th or 6th semeste n field media informatics, 2	er er 2nd and 3rd semester
Classes and lectures:		Workload:	
Computer-Supported Teaching Computer-Supported Teaching	g and Learning (lecture, 2 SWS) g and Learning (exercise, 1 SWS)	75 Hours private45 Hours in-class	studies sroom work
Contents of teaching:			
 Introduction to the course Introduction to the field of app Pedagogical foundations Overview Digital teaching-lear Digital transformation within t Learning spaces and learning e Classification of educational te Standards for teaching and lear Development processes Learning Analytics Gamification Legal framework 	olication and research ning scenarios he university context environments echnologies arning technologies		
 Qualification-goals/Competencies: Students are able to summariz They are able to analyze trend contexts. They have the ability to familia applicable specifications. 	e fundamentals, principles and a s and developments in the field a arize themselves with an existing	pplications of computer-b nd to assess them with re open source system and t	ased teaching and learning systems. gard to their use in concrete application o develop it further independently along the
Grading through: • portfolio exam - the concrete e	examination elements and their w	veights will be published i	n the course
Responsible for this module: • Prof. DrIng. Nicole Jochems Teacher: • Institute for Multimedia and In • Prof. DrIng. Nicole Jochems • MitarbeiterInnen des Instituts	teractive Systems		
litoraturo:			
 H. Kritzenberger: Multimediale J. Haake, G. Schwabe & M. Wes S. Schön, M. Ebner: Lehrbuch f 	e und Interaktive Lernräume - Mür ssner: CSCL-Kompendium 2.0 - Mü ür Lernen und Lehren mit Techno	nchen: Oldenbourg, 2005 ünchen: Oldenbourg, 2012 ologien - Berlin, epubli 2. <i>A</i>	2 Auflage, 2013
Language: • offered only in German			
Notes:			



Prerequisites for attending the module: - None

Prerequisites for the exam: - None

Exam(s):

- CS5610-L1 Computergestütztes Lernen und Lehren, Portfolio exam, 100% of the module grade



CS5615-KP04, CS5615 - Computer-Supported Cooperative Work (CSCW) in Safety-Critical Contexts (CGKoop)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	Currently not available		4	
 Course of study, specific field and term: Bachelor Media Informatics 2020 (optional subject), media informatics, 5th or 6th semester Bachelor IT-Security 2016 (optional subject), computer science, Arbitrary semester Bachelor Media Informatics 2014 (optional subject), media informatics, 5th or 6th semester Master Computer Science 2012 (optional subject), specialization field media informatics, 2nd or 3rd semester 				
Classes and lectures:		Workload:		
 Computer-Supported Cooperative Work (CSCW) in Safety-Critical Contexts (lecture, 2 SWS) Computer-Supported Cooperative Work (CSCW) in Safety-Critical Contexts (exercise, 1 SWS) Stafety-Critical Contexts (exercise, 1 SWS) 		studies vroom work vreparation		
Contents of teaching:				
 Introduction Socio-technical systems Designing groupware Classifying groupware Supporting awareness Supporting communication Supporting coordination Supporting teams Supporting communities Technical integration User interfaces for groupware 				
Qualification-goals/Competencies: The students know the basics, princi They can describe representative plate They are able to analyze, design, implate 	ples and applications of co atforms and systems for CS plement and evaluate CSCN	omputer-supported cooper CW. W systems in an applicatior	ative work (CSCW) and how to apply them. n- and user-oriented way.	
Grading through: • Written or oral exam as announced by the examiner				
Responsible for this module: N.N. Teacher: Institute for Multimedia and Interactive Systems 				
 Literature: T. Gross & M. Koch: Computer-Supported Cooperative Work - München: Oldenbourg-Verlag, 2007 D. Coleman: Groupware - Collaborative Strategies for Corportate LANSs and Intranets - San Francisco: Prentice-Hall 1997 G. Schwabe et al.(Hrsg.): CSCW-Kompendium - Berlin: Springer 2001 F. Lehner, S. Dustdar (Hrsg.): Telekooperation in Unternehmen - Wiesbaden: Deutscher Universitäts-Verlag 1997 M. Beaudouin-Lafon (Hrsg.): Computer-Supported Cooperative Work - New York: Wiley 1998 				
Language: • offered only in German				
Notes:				



Admission requirements for taking the module: - None

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

Module examination(s):

- CS5615-L1 Computer-aided cooperation in safety-critical systems, written exam, 90min, 100% of the module grade.



CS5640-KP04 - Sociology of Media Networks (SozioNMed)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each summer semester		4	
Course of study, specific field and term: • Master Media Informatics 2014 (opt • Master Computer Science 2012 (opt	ional subject), media inforr tional subject), specializatic	matics, Arbitrary semester on field media informatics, 2	nd or 3rd semester	
Classes and lectures:	Classes and lectures: Workload:			
 Sociology of Media Networks (lecture, 2 SWS) Sociology of Media Networks (exercise, 1 SWS) Sociology of Media Networks (exercise, 1 SWS) 45 Hours in-classroom work 20 Hours exam preparation 		studies room work preparation		
Contents of teaching: Introduction and Overview Sociology and Computer Science Social structures in network societies Society in media networks Sociological basics of the network society Ethics in media networks 				
 Qualification-goals/Competencies: The students can use the sociologic They are able to understand and pr advantages and disadvantages con 	al basics, theories and stat edict moral conflicts arising cerning society.	istics for orientation in the in g due to technological deve	nformational network society. lopments and can explain the resulting	
Grading through: • Written or oral exam as announced	by the examiner			
Responsible for this module:				
Prof. Dr. rer. nat. Michael Herczeg				
Teacher: Institute for Multimedia and Interac	tive Systems			
 Prof. Dr. rer. nat. Michael Herczeg MitarbeiterInnen des Instituts 				
Literature: • : • : • :				
Language: offered only in German				





CS5650-KP04 - Computer and Media Art (CMKunst)			
Duration:	Turnus of offer:		Credit points:
1 Semester	each summer semester		4
Course of study, specific field and term: • Master Media Informatics 2020 (opti • Master Media Informatics 2014 (opti • Master Computer Science 2012 (opti	onal subject), media inform onal subject), media inform ional subject), specializatior	atics, Arbitrary semester atics, Arbitrary semester n field media informatics, 2	nd or 3rd semester
Classes and lectures:		Workload:	
 Computer- and Media-Art (lecture, 2 Computer- and Media-Art (exercise, 	: SWS) 1 SWS)	55 Hours private45 Hours in-class20 Hours exam p	studies room work reparation
Contents of teaching:			
 Introduction and Overview History of Technology and Art Introduction to the art of modernism Digital technology as a tool and reflected medium of CMA Sound and music Political art Interactive installations and environments Telepresence, telematics, telerobotics - body and identity Art & AI VR and AR art Artificial Life and Artificial Life Art Summary and outlook 			
 Qualification-goals/Competencies: The students know the importance of computers and interactive media for the arts. hey are able to understand and judge media art technologically and artistically in the cultural context. They understand the mutual importance of technology and art in a historical reflection. 			
Grading through: Regular attendance at seminars written homework 			
Responsible for this module: • Dr. Thomas Winkler Teacher: • Institute for Multimedia and Interact • Dr. Thomas Winkler	ive Systems		
Language: • offered only in German			
Notes: Admission requirements for taking the - None	e module:		
Admission requirements for participation in module examination(s): - Active participation in the exercises in small groups as specified at the beginning of the semester			
Module examination(s): - CS5650-L1 Computer and Media Art,	term paper, 100% of the m	odule grade	





CS5660-KP04 - Music and Computer (MusikComp)				
Duration:	Turnus of offer:	Credit points:		
1 Semester	every summer semester	4		
Course of study, specific field and • Bachelor Media Informatics • Bachelor Media Informatics • Master Computer Science 20	l term: 2020 (optional subject), media info 2014 (optional subject), computer s 012 (optional subject), specialization	matics, 5th or 6th semester cience, 5th or 6th semester n field media informatics, 2nd or 3rd semester		
Classes and lectures:Workload:• Music and Computer (lecture, 2 SWS)• 55 Hours private studies• Music and Computer (exercise, 1 SWS)• 45 Hours in-classroom work• 20 Hours exam preparation				
Contents of teaching: Introduction, Overview, Scientific, Artificial and Ordinary Background History of Music Technology Analog and Digital Soundrecording Audio-Software (theory and practice) Analog Soundproduction, Electrical Instruments, Electronic Music aud Synthesizer Digital Soundsynthesis, Virtual Studio Technology (theory and practice) nalog and Digital Soundcontrolling, MIDI-Technology MIDI-Software, esp. Sequenzer (theory and practice) Musical Programming, Interactive Performance (theory and practice) Interface-Technology Digital Performance 				
 Qualification-goals/Competencies: The students know the theories, methods and technologies for digital music and its production. They can analyse, plan, implement and evaluate applications of digital music together with musicians as well as with experts from musical science and from audio technology. Grading through: Written or oral exam as appounced by the examiner 				
Responsible for this module: • Prof. DrIng. Nicole Jochem Teacher: • Institute for Multimedia and • PD Dr. habil. Joachim Stang	s Interactive Systems e-Elbe			
Literature: • Peter Manning: Electronic a	nd Computer Music - Oxford Univer	sity Press, 2013		
Language: • offered only in German				
Notes: Prerequisites for attending the - None Prerequisites for the exam: - None	e module:			
Exam(s): - CS5660-L1 Musik und Computer, Klausur, 90min, 100% der Modulnote				





	CS5670 - Design theory and esthe	etics of interactive me	edia (Design)
Duration:	uration: Turnus of offer: Credit points:		Credit points:
1 Semester	mester not available anymore		4
Course of study, specific fi	eld and term:		
Master Computer Sci	ence 2012 (optional subject), specializatior	n field media informatics, 2	nd or 3rd semester
Classes and lectures:		Workload:	
 Designtheory and Esthetics of interactive media (lecture with exercises, 3 SWS) 55 Hours private studies and exercises 30 Hours in-classroom work 20 Hours exam preparation 15 Hours group work 		studies and exercises room work reparation vork	
Contents of teaching:			
 Introduction and Ove Subregions of the De History of Interaction Design Theory Aesthetics Design Principles and Text and Typography Image-Sound Media Surfaces, Objects and Interactive Objects 	erview esign and its Present Importance n- and Interface Design d Design Methods y d Structures		
Qualification-goals/Compe • Students are capable • They can use basic m • They are familiar with	etencies: e of scientific and theoretical reflection of ir nethods for designing interactive multimed h selected examples of interactive, multime	nteractive, multimedia desi lia systems. edia designs.	gn.
Grading through: • Written or oral exam	as announced by the examiner		
Responsible for this modu • Dr. Thomas Winkler Teacher: • Institute for Multimer • Dr. Thomas Winkler	le: dia and Interactive Systems		
Litavatuva			
G.M. Buurmann (Hrsg M. Herczeg: Interakti	g.): Total Interaction: Theory and Practice of onsdesign - Oldenbourg-Verlag, 2006	f a New Paradigm for the D	Design Disciplines - Birkhäuser Verrlag, 2005
Language: • offered only in Germ	an		
Notes: Das Modul wird ab WS	2014/15 abgelöst durch CS4235 - Medien-	und Designtheorie.	



CS5680-KP04 - Master Seminar Media informatics (MSemMedien)			
Duration:	Turnus of offer:	Credit points:	Max. group size:
1 Semester	normally each year in the summer	r semester 4 (Typ B)	15
Course of study, spe • Master Media • Master Compu	cific field and term: Informatics 2014 (compulsory), interdiscipli Iter Science 2012 (optional subject), speciali	nary competence, 2nd semester ization field media informatics, 2nd	d or 3rd semester
Classes and lectures: • Master Seminar Media Informatics (seminar, 2 SWS)		 Workload: 60 Hours work on an individual topic with written and oral presentation 30 Hours in-classroom work 30 Hours private studies 	
Contents of teaching • Familiarize wit • Self depender • Presentation a	g: :h a challenging academic topic of media in it work on a scientific problem and its soluti ind discussion of results	formatics ion methods	
Qualification-goals/ • Students can • They are capa • They can pres • They can com • They can follo	Competencies: work up a scientific topic thoroughly. ble of presenting the results in a written do ent and discuss a scientific problem in Engli ment scientific work from a critical point of w a scientific presentation and question it ir	cumentation and an oral presentat sh. view. n an open discussion.	tion.
Grading through: • term paper • oral presentat	on		
Responsible for this Prof. DrIng. N Teacher: Institute for M Prof. Dr. rer. na Prof. DrIng. N MitarbeiterIn	module: licole Jochems ultimedia and Interactive Systems at. Michael Herczeg licole Jochems nen des Instituts		
Literature: • : is selected in	dividually		
Language: • German and E	nglish skills required		



CS4010 - Safety and Security (SafeSec)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	not available anymore		4	
Course of study, specific field and term: • Master Computer Science 2012 (con • Master Computer Science 2012 (opt • Master Computer Science 2012 (con	npulsory), specialization fie ional subject), advanced cu npulsory), specialization fie	ld IT security and safety, 2n ırriculum security, 2nd sem ld software systems engine	d semester ester ering, 2nd semester	
Classes and lectures: • Safety and Security (lecture with exercises, 3 SWS)		 Workload: 65 Hours private studies and exercises 45 Hours in-classroom work 10 Hours exam preparation 		
Contents of teaching: • Temporal logics • Concurrency • Basic concepts of safety • Formal modeling of safety requirements • Verification of safety requirements • Model checking and tools for verification • Basic concepts of security • Verification of protocols				
 Qualification-goals/Competencies: Ability to formalize and analyze the Ability to analyze the security prope Knowledge of the basic techniques Understanding the limits of automa 	safety properties of a syste erties of systems of model-checking tic verification	ms		
Grading through: • Written or oral exam as announced	by the examiner			
Responsible for this module: • Prof. Dr. Rüdiger Reischuk Teacher: • Institute for Theoretical Computer S • Prof. Dr. Rüdiger Reischuk • Prof. Dr. Maciej Liskiewicz	cience			
Literature: M. Huth, M. Ryan: Logic in Compute Z. Manna, A. Pnueli: Temporal Verific D. Salomon: Data Privacy and Securi C. Baier, P. Katoen: Principles of Moc H. Tipton, M. Krause: Information Se E. Clarke, O. Grumberg, D. Peled: Moc	r Science - Cambridge 200 cation of Reactive Systems ity - Springer 2003 del Checking - MIT Press 20 curity Management - Auerl odel Checking - MIT Press 1	4 :Safety - Springer 1995 08 bach 2000/2001 999		
Language:English, except in case of only Germ	an-speaking participants			



CS4015 - Requirements Engineering (ReqEng)				
Duration:	Turnus of offer:	Credit points:		
1 Semester	not available anymore	4		
Course of study, specific fiel • Master Computer Scient	d and term: nce 2012 (optional subject), specializatio	n field software systems engineering, 3rd semester		
Classes and lectures:		Workload:		
 Requirements Engineering (lecture, 2 SWS) Requirements Engineering (exercise, 1 SWS) 		 60 Hours private studies and exercises 45 Hours in-classroom work 15 Hours exam preparation 		
Contents of teaching:				
 Requirements enginee Classification of require Description of require Methods for requirem Validation of requirem Analysis of a requirem Management and trac Requirements in partic 	rring as a phase of the software life cycle ements ments ents engineering ents document ing of requirements cular application domains			
Qualification-goals/Compet • Understanding the im • Knowledge the basic p • Ability to identify and • Ability to analyse a giv • Recognizing the difficu	encies: portance of RE for the software developr procedures and description methods use to describe functional and nonfunctiona ren requirements document ulties when elucidating the requirement	nent process d for requirements engineering I requirements of an application s of real world projects		
Grading through: • Written or oral exam a	s announced by the examiner			
Requires: • Software Construction • Specification and Mod	(CS4120) elling (CS4020)			
Responsible for this module • Prof. Dr. Martin Leucke	: :r			
Teacher:Institute of Software Teacher	echnology and Programming Languages	;		
Prof. Dr. Martin Leucke	ir			
Literature: • : • : • : • : • : • : • :				
• English, except in case	of only German-speaking participants			



CS4030 - Semantics and Verification (SemVeri)				
Duration:	Turnus of offer:	Credit points:		
1 Semester	not available anymore	4		
Course of study, specific field and • Master Computer Science 20	term: 12 (optional subject), specializatio	n field software systems engineering, 3rd semester		
 Classes and lectures: Semantics and Verification (lecture, 2 SWS) Semantics and Verification (exercise, 1 SWS) 		 Workload: 60 Hours private studies and exercises 45 Hours in-classroom work 15 Hours exam preparation 		
Contents of teaching: • Logic calculi • operational, denotational and • Verification and software dev • Foundations of verifying imp • Verification of sequential pro • Tools for verification	d axiomatic semantics elopment erative programs grams			
Qualification-goals/Competencies: • Understanding semantics and • Understanding the demand f • Knowing the verification rule • Ability to manually verify small	d its impact or verification s of important classes of imperati all imperative programs	ve programs		
Grading through: • Written or oral exam as anno	unced by the examiner			
Responsible for this module: • Prof. Dr. Martin Leucker Teacher: • Institute of Software Technological • Prof. Dr. Martin Leucker	ogy and Programming Languages	;		
Literature: • : • : • : • : • : • : Language:				
English, except in case of only	/ German-speaking participants			


	CS4120 - Software Construction (SoftKon)		
Duration:	Turnus of offer:	1	Credit points:
1 Semester	not available anymore	1	4
Course of study, specific field and term: • Master Computer Science 2012 (com • Master Computer Science 2012 (com	npulsory), advanced curricu npulsory), specialization fiel	lum programming, 2nd or 3 d software systems engineer	rd semester ring, 1st semester
Classes and lectures:	Workload:ire, 2 SWS)60 Hours private studies and exercisescise, 1 SWS)45 Hours in-classroom work15 Hours exam preparation		•
Software Construction (lecture, 2 SW Software Construction (exercise, 1 SV			pom work eparation
Contents of teaching: • Challenges when designing and ma • Object-oriented software design • Software architectures • Software components • Design patterns • Refactoring and reengineering • Product lines • CASE tools	 cents of teaching: Challenges when designing and maintaining large software systems Object-oriented software design Software architectures Software components Design patterns Refactoring and reengineering Product lines CASE tools 		
 Qualification-goals/Competencies: Knowing the concepts and methods of object-oriented software development Ability to perform object-oriented analysis and design Familiarity with the basic software architectures Knowing common component models Ability to use design patterns in an adequate way Knowledge of basic methods for reengineering software 			
Grading through: • Viva Voce or test			
Responsible for this module: Prof. Dr. Martin Leucker Teacher: Institute of Software Technology and Programming Languages Prof. Dr. Martin Leucker 			
 Literature: P. Clements, L. Northrop: Software Product Lines - Addison Wesley 2007 M. Fowler, K. Beck, J. Brant, W. Opdyke, D. Roberts: Refactoring: Improving the Design of Existing Code - Addison Wesley 1999 E. Gamma, R. Helm, R. Johnson, J. Vlissides: Design Patterns: Elements of Reusable Object-Oriented Software - Pearson 2000 B. Meyer: Object-Oriented Software Construction - Prentice Hall 1997 C. Szyperski: Component Software - Beyond Object-Oriented Programming - Addison-Wesley 2002 			isting Code - Addison Wesley 1999 riented Software - Pearson 2000 ey 2002
Language: • English, except in case of only Germ	an-speaking participants		



CS4136 - Software and System Testing (Testen)			
Duration:	Turnus of offer:	Credit points:	
1 Semester	not available anymore	4	
Course of study, specific field and term: • Master Computer Science 2012 (or • Master Computer Science 2012 (or • Master Computer Science 2012 (or	: otional subject), specializatic otional subject), specializatic otional subject), advanced c	on field IT security and safety, 1st or 2nd semester on field software systems engineering, 2nd or 3rd semester urriculum programming, 2nd or 3rd semester	
Classes and lectures: • Software and System Testing (lectric) • Software and System Testing (exercised)	ng (lecture, 2 SWS) ng (exercise, 1 SWS) e 60 Hours private studies and exercises • 45 Hours in-classroom work • 15 Hours exam preparation		
Contents of teaching: • Quality aspects of software systems • Analysis and verification techniques for software systems • Testing levels • Testing process • Kinds of tests • Test case generation			
Qualification-goals/Competencies: • Basic knowledge of analysis and ve • Familiarity with the specification of • Knowledge on different technique • Knowledge on the operation proce • Ability to develop software of high	erification techniques of correctness and safety pro es for testing hardware and s ess of test case generation t her quality with the learned	perties software systems ools techniques	
Grading through: Written or oral exam as announced by the examiner 			
Responsible for this module: • Prof. Dr. Martin Leucker Teacher: • Institute of Software Technology a • Prof. Dr. Martin Leucker	nd Programming Language	S	
Literature: • G.J. Myers: The Art of Software Tes • B. Beizer: Software Testing Technic • M. Broy, B. Jonsson, JP. Katoen, N	ting - John Wiley, 1979 ques - Van Nostrand Reinhol 1. Leucker, A. Pretschner: Mo	d, 1999 del-Based Testing of Reactive Systems - Springer, 2005	
Language: • English, except in case of only Ger	man-speaking participants		
Notes: It is recommended to attend this mo	odule in combination with m	odule CS4137 Runtime Verification.	



	CS4137 - Runtir	ne Verification (RV)
Duration:	Turnus of offer:	Credit points:
1 Semester	not available anymore	4
Course of study, specific fie • Master Computer Scie • Master Computer Scie • Master Computer Scie	eld and term: ence 2012 (optional subject), specializati ence 2012 (optional subject), specializati ence 2012 (optional subject), advanced o	ion field IT security and safety, 1st or 2nd semester ion field software systems engineering, 2nd or 3rd semester curriculum programming, 2nd or 3rd semester
Classes and lectures: • Runtime Verification • Runtime Verification	tion (lecture, 2 SWS) tion (exercise, 1 SWS) • 60 Hours private studies and exercises • 45 Hours in-classroom work • 15 Hours exam preparation	
Contents of teaching: Quality aspects of sof Analysis and verificat Specification of corre synthesis of monitors diagnosis of errors in realization of monito	tware systems ion techniques for software systems ctness properties for the observation of software systems software systems ring frameworks	5
Qualification-goals/Compe • Basic knowledge of a • Familiarity with the s • Knowledge of technic • Ability to develop sof	tencies: nalysis and verification techniques pecification of correctness and safety pro ques for the synthesis of monitors ftware of higher quality with the learned	operties I techniques
Grading through: • Written or oral exam	as announced by the examiner	
Responsible for this modul • Prof. Dr. Martin Leuck Teacher: • Institute of Software • Prof. Dr. Martin Leuck	e: er Technology and Programming Language	es
Literature: • : • : • : • :		
Language: • English, except in cas	e of only German-speaking participants	
Notes: It is recommended to a	ttend this module in combination with r	nodule CS4136 Software and System Testing.



CS4138 - Model Checking (ModelCheck)				
Duration:	Turnus of offer:	Credit points:		
1 Semester	each winter semester	4		
Course of study, specific field and term: • Master Computer Science 2012 (opti • Master Computer Science 2012 (opti • Master Computer Science 2012 (opti	onal subject), specializatio onal subject), specializatio onal subject), advanced c	n field IT security and safety, 1st or 2nd semest n field software systems engineering, 2nd or 3 rriculum programming, 2nd or 3rd semester	ter rd semester	
Classes and lectures:		Workload:		
 Model Checking (lecture, 2 SWS) Model Checking (exercise, 1 SWS) 	 60 Hours private studies and exercises 45 Hours in-classroom work 15 Hours exam preparation 		es	
 Contents of teaching: Quality aspects of software systems Analysis and verification techniques for software systems Basic techniques for model checking Advanced techniques for model checking 				
 Qualification-goals/Competencies: Basic knowledge of analysis and verification techniques Familiarity with the specification of correctness and safety properties Knowledge on different techniques for model checking hardware and software systems Knowledge on the structure of model checkers 				
Grading through: • Written or oral exam as announced by the examiner				
Responsible for this module: • Prof. Dr. Martin Leucker Teacher: • Institute of Software Technology and Programming Languages				
Eiterature: • :				
 English, except in case of only German-speaking participants 				
Notes: It is recommended to attend this mode Security.	ule in combination with m	odule CS4137 Runtime Verification and with m	odule CS4010 Safety and	



CS4140-KP04, CS4140 - Mobile and Distributed Databases (MVDB)			
Duration:	Turnus of offer:		Credit points:
1 Semester	each winter semester		4
 Course of study, specific field and term: Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester Master Medical Informatics 2019 (optional subject), ehealth / infomatics, 1st or 2nd semester Master Medical Informatics 2014 (optional subject), ehealth / infomatics, 1st or 2nd semester Master Media Informatics 2014 (optional subject), ehealth / infomatics, 1st or 2nd semester Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester Master Computer Science 2012 (optional subject), advanced curriculum distributed information systems, 3rd semester Master Computer Science 2012 (compulsory), specialization field software systems engineering, 1st semester 			
 Mobile and Distributed Databases (I Mobile and Distributed Databases (e 	ecture, 2 SWS) exercise, 1 SWS)	 65 Hours private 45 Hours in-classi 10 Hours exam p 	studies room work reparation
 Contents of teaching: The contents of the lecture covers query processing, transactions and replication in - centralised database management systems - parallel database management systems - distributed database management systems - mobile database management systems 			
 Qualification-goals/Competencies: Students can explain the differences between centralised, parallel, distributed and mobile database management systems. They can judge about the practical suitability of different synchronization approaches for distributed and mobile transactions for a given problem. They can apply approaches for distributed and mobile query processing. They can choose suitable replication approaches for a given application and justify their choices. They can recognize and deal with the special difficulties and sources of error in distributed and mobile environments. 			
Grading through: • Oral examination			
Responsible for this module: • Prof. Dr. Sven Groppe Teacher: • Institute of Information Systems • Prof. Dr. Sven Groppe			
 Literature: A. Kemper, A. Eickler: Datenbanksysteme - 2006 T. Conolly, C. Begg: Database Systems - A Practical Approach to Design, Implementation, and Management - Addison-Wesley 2005 E. Rahm: Mehrrechner-Datenbanksysteme - Addison-Wesley 1994 P. Dadam: Verteilte Datenbanken und Client/Server Systeme - Springer 1996 H. Höpfner, C. Türker, B. König-Ries: Mobile Datenbanken und Informationssysteme - dpunkt.verlag 2005 B. Mutschler, G. Specht: Mobile Datenbanksysteme - Springer 2004 V. Kumar: Mobile Database Systems - Wiley-Interscience 2006 			
Language: offered only in German Notes:			



Admission requirements for taking the module: - None

Admission requirements for participation in module examination(s): - Active participation in lecture and tutorial

Module Examination(s):

- CS4140-L1: Mobile and Distributed Databases, oral exam, 100% of module grade.



CS4142 -	Anfrageverarbeitung	und Transaktionen (AnfrTrans)
Duration:	Turnus of offer:		Credit points:
1 Semester	not available anymore		4
Course of study, specific field and term: • Master Computer Science 2012 (opt • Master Computer Science 2012 (opt	ional subject), specializatior ional subject), advanced cu	n field software systems en rriculum distributed inform	gineering, 3rd semester ation systems, 2nd or 3rd semester
Classes and lectures:Workload:• Anfrageverarbeitung und Transaktionen (lecture, 2 SWS)• 65 Hours private• Anfrageverarbeitung und Transaktionen (exercise, 1 SWS)• 45 Hours in-clas• 10 Hours exam		studies room work reparation	
Contents of teaching: Introduction Architecture of Data Base Systems Basic Optimzation Concepts Basics in Storage Management Transaction Management in Data Base Distributed Data Bases Data Structures for Content Based A Byte-oriented Files Sequentielle record-oriented files Files with Direct Record Access A structural Modell for DBMS System Buffer Management Record Management Access Paths Record-oriented Data Base Interface Set-oriented Data Base Interface Error Recovery	teaching: duction itecture of Data Base Systems Optimzation Concepts s in Storage Management iaction Management in Data Base Systems ibuted Data Bases Structures for Content Based Access oriented Files entielle record-oriented files with Direct Record Access uctural Modell for DBMS em Buffer Management rd Management ss Paths rd-oriented Data Base Interface oriented Data Base Interface Recovery		
Qualification-goals/Competencies: Knowledge of the basic architecture Knowledge of basic implemetation 	e of data base systems and optimization concepts i	n data base systems	
Grading through: • written exam			
Responsible for this module: • Prof. Dr. Sven Groppe Teacher: • Institute of Information Systems • Prof. Dr. Sven Groppe Literature: • : • :			
Language: • offered only in German			



CS4151-KP04, CS4151 - Architectures for Distributed Applications (SVA)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each summer semester		4	
 Course of study, specific field and term: Master MES 2020 (optional subject), computer science / electrical engineering, Arbitrary semester Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester Master Medical Informatics 2019 (optional subject), ehealth / infomatics, 1st or 2nd semester Master Medical Informatics 2014 (optional subject), ehealth / infomatics, 1st or 2nd semester Master MES 2014 (optional subject), computer science / electrical engineering, 1st or 2nd semester Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester Master Computer Science 2012 (optional subject), advanced curriculum distributed information systems, 2nd semester Master Computer Science 2012 (optional subject), advanced curriculum parallel and distributed system architecutres, 2nd or 3rd semester Master Computer Science 2012 (compulsory), specialization field software systems engineering, 2nd semester 				
Classes and lectures:		Workload:		
 Architectures for Distributed Applica Architectures for Distributed Applica 	tions (lecture, 2 SWS) tions (exercise, 1 SWS)	 45 Hours in-class 45 Hours private 30 Hours exam private 	room work studies reparation	
 Contents of teaching: Motivation Software Architectures Basics: HTTP, XML & Co N-Tier Applications Service-Oriented and Event-Driven Architectures (SOA and EDA) Web-Oriented Architectures (Web 2.0) Overlay Networks Peer-to-Peer Grid and Cloud Computing Internet of Things Qualification-goals/Competencies: The students are able to name the most important archiectures for distributed systems, explain them, and compare them to each other. For each architecture, they know the most prominent and important implementation platforms and basically know how to use them. For a given problem, they can analyze which architecture is best suited to solve it, and they can design a plan for the solution's realization 				
Grading through:				
Oral examination				
Responsible for this module: Prof. DrIng Horst Hellbrück Teacher: Institute of Telematics Prof. DrIng Horst Hellbrück 				
Literature: • J. Dunkel, A. Eberhart, S. Fischer, C. K • I. Melzer et.al.: Service-Orientierte Ar	leiner, A. Koschel: Systema chitekturen mit Web Servic	rchitekturen für verteilte Ar æs - Spektrum-Verlag 2010	nwendungen - Hanser-Verlag 2008	
Language: • offered only in German				



Notes:

Admission requirements for taking the module:

- None

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

Module Exam(s):

- CS4151-L1 System Architectures for Distributed Applications, oral exam, 100% of module grade.



CS5140-KP04, CS5140 - Semantic Web (SemWeb)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each winter semester		4	
 Course of study, specific field and term: Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester Master Medical Informatics 2019 (optional subject), ehealth / infomatics, 1st or 2nd semester Master Medical Informatics 2014 (optional subject), ehealth / infomatics, 1st or 2nd semester Master Medical Informatics 2014 (optional subject), ehealth / infomatics, 1st or 2nd semester Master Media Informatics 2014 (optional subject), ehealth / infomatics, 1st or 2nd semester Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester Master Computer Science 2012 (optional subject), advanced curriculum distributed information systems, 2nd or 3rd semester Master Computer Science 2012 (optional subject), specialization field software systems engineering, 2nd or 3rd semester 				
Classes and lectures:		Workload:		
 Semantic Web (lecture, 2 SWS) Semantic Web (exercise, 1 SWS) 		 65 Hours private 45 Hours in-clas 10 Hours exam private 	e studies sroom work preparation	
Contents of teaching:				
 Introduction with overview of the W Data management for Semantic Wel Query processing for Semantic Web Processing strategies for Semantic Web 	'3C Semantic Web family of b data, in particular indexin queries (central, parallel, ar Veb rules and ontologies	languages g approaches nd distributed, in particula	r in the cloud)	
Qualification-goals/Competencies:				
 Students can judge about the possibilities and limits of the Semantic Web. They can evaluate the consequences of the Semantic Web approach for data modelling, adminstration and processing, and finally for applications. They can develop Semantic Web applications. They can explain and apply specialized approaches for Semantic Web databases. They can discuss about open research questions in the area of the Semantic Web. 				
Grading through: Oral examination	Grading through: Oral examination			
Responsible for this module: • Prof. Dr. Sven Groppe Teacher: • Institute of Information Systems • Prof. Dr. Sven Groppe Literature: • P. Hitzler, M. Krötzsch, S. Rudolph: Foundations of Semantic Web Technologies - Chapman & Hall / CRC, 2009 • T. Segaran, J. Taylor, C. Evans: Programming the Semantic Web - O'Reilly, 2009				
 F. Bry, J. Maluszynski: Semantic Techniques for the Web - Springer, 2009 J. T. Pollock: Semantic Web for Dummies - Wiley, 2009 J. Hebeler, M. Fisher, R. Blace, A. Perez-Lopez, M. Dean: Semantic Web Programming - Wiley, 2009 G. Antoniou, F. van Harmelen: A Semantic Web Primer - MIT Press, 2008 V. Kashyap, C. Bussler, M. Moran: The Semantic Web - Springer, 2008 S. Groppe: Data Management and Query Processing in Semantic Web Databases - Springer, 2011 				
Language:				
ottered only in German				
Notes:				



Admission requirements for taking the module: - None

Admission requirements for participation in module examination(s): - Active participation in lecture and tutorial

Module Exam(s):

- CS5140-L1: Semantic Web, oral exam, 100% of module grade.



CS5158-KP04, CS5158 - Advanced Internet Technologies (AdInternet)			
Duration:	Turnus of offer:		Credit points:
1 Semester	every summer semester		4
 Course of study, specific field and term: Master Media Informatics 2020 (optional subject), computer science, Arbitrary semester Master Medical Informatics 2019 (optional subject), ehealth / infomatics, 1st or 2nd semester Master Medical Informatics 2014 (optional subject), ehealth / infomatics, 1st or 2nd semester Master Medical Informatics 2014 (optional subject), ehealth / infomatics, 1st or 2nd semester Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester Master Media Informatics 2014 (optional subject), computer science, Arbitrary semester Master Computer Science 2012 (optional subject), advanced curriculum enterprise IT, 2nd or 3rd semester Master Computer Science 2012 (optional subject), specialization field software systems engineering, 2nd or 3rd semester Master Computer Science 2012 (optional subject), advanced curriculum distributed information systems 2nd or 3rd semester 			
Classes and lectures:		Workload:	
 Advanced Internet Technologies (le Advanced Internet Technologies (e 	ecture, 2 SWS) exercise, 1 SWS)	 60 Hours private 45 Hours in-class 15 Hours exam p 	studies sroom work preparation
Contents of teaching:			
 Introduction and fundamentals Fundamental Internet design principles Problems of today's Internet architecture Backbone Technologies Mobile Internet IPv6 und related topics Delay Tolerant Networks (DTN) Internet of Services / Internet of Things Peer-To-Peer networks Big Data Goals architectures algorithms and protocols for the future Internet 			
 Qualification-goals/Competencies: Understand the fundamental design decisions that have led to today's Internet architecture Understand the original design goals of the Internet and realize the implications that the emphasis on certain of them has on today's networks Learn about essential, universally valid criteria for the design of networks and applications (e.g., end-to-end argument, fate sharing, etc.) Know technological as well as societal developments that have led to massive changes in the Internet's infrastructure (growth, innovations, mobile communications,) Identify problems of the Internet's architecture and understand potential solutions by comparing different approaches Become acquainted with the Future Internet research field and learn about novel approaches to research and shape the Internet of the future 			
Grading through:			
Written or oral exam as announced	by the examiner		
Responsible for this module: • Prof. Dr. Stefan Fischer Teacher: • Institute of Telematics • Dr. Mohamed Hail			
 Literature: Olivier Hersent, David Boswarthick, Omar Elloumi: The Internet of Things: Key Applications and Protocols - Wiley, 2012 Athanasios V. Vasilakos, Yan Zhang, Thrasyvoulos Spyropoulos: Delay Tolerant Networks: Protocols and Applications - CRC Press, 2012 Desitti D. Alderdring M. El Dick B2D Tackning (2000) - CRC Press, 2012 			
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Language:

• German and English skills required

Notes:

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- None

Module Examination(s):

- CS5158-L1: Advanced Internet Technologies, oral examination, 100% of module mark.

(Was also part of CS4518-KP12)



CS5480 - Seminar Software Systems Engineering (SemSSE)				
Duration:	Turnus of offer:	Credit points:	Max. group size:	
1 Semester	not available anymore	4 (Тур В)	15	
Course of study, spe • Master Compu	c ific field and term: Iter Science 2012 (optional subject), specializati	on field software systems engi	neering, 3rd semester	
Classes and lectures Seminar Softw 	: vare Systems Engineering (seminar, 2 SWS)	Workload: • 60 Hours work on a presentation • 30 Hours private st • 30 Hours in-classro	in individual topic with written and oral udies om work	
Contents of teaching Advanced top 	g: ics from the field of software systems engineeri	ing		
Qualification-goals/ Instructing me Ability to acqu Ability to sum Ability to give Ability to discu	Competencies: ethods for scientific work Jaint oneself with a scientific subject marize the contents in written form a talk about complex issues in a comprehensib Juss scientific problems	ıle way using proper terminolog	ЭУ	
Grading through: • participation i	n discussions			
Requires: • Mobile and Di • Architectures • Software Cons	stributed Databases (CS4140-KP04, CS4140) for Distributed Applications (CS4151-KP04, CS4 truction (CS4120)	151)		
Responsible for this Prof. Dr. rer. na Prof. Dr. Stefan Prof. Dr. Martin Teacher: Institute for Th Institute of Te Institute of Inf Institute of So Prof. Dr. Martin Prof. Dr. Stefan Prof. Dr. rer. na	module: at. habil. Ralf Möller n Fischer n Leucker neoretical Computer Science lematics ormation Systems ftware Technology and Programming Language n Leucker n Fischer at. habil. Ralf Möller	25		
Language: • offered only ir	ı English			



	CS5490 - Lab Software Sy	stems Engineering (PrSSE)	
Duration:	Turnus of offer:	Credit points:	
1 Semester	not available anymore	4 (Тур В)	
Course of study, specific field a • Master Computer Science	nd term: 2012 (compulsory), specialization fiel	d software systems engineering, 3rd semester	
Classes and lectures:		Workload	
 Lab Software Systems Eng SWS) 	 workload: ms Engineering (programming project, 3 65 Hours private studies 45 Hours in-classroom work 10 Hours oral presentation (including preparation) 		
Contents of teaching: • Design and implementation	on of an advanced component-based	software/hardware system in team work	
 Qualification-goals/Competencies: Advanced skills in designing complex software/hardware systems Ability to derive a system design from a requirements specification Ability to plan a component-based architecture meeting the system design Ability to implement, to test, and to integrate components Ability to document, to present, to evaluate and to improve the implemented system Ability to cooperate within a teamfor a successful project 			
Grading through: • documentation			
Requires: • Architectures for Distribut • Software Construction (CS • Mobile and Distributed Da	ed Applications (CS4151-KP04, CS415 4120) atabases (CS4140-KP04, CS4140)	1)	
Responsible for this module: • Prof. Dr. rer. nat. habil. Ralf Möller • Prof. Dr. Stefan Fischer • Prof. Dr. Martin Leucker Teacher: • Institute for Theoretical Computer Science • Institute of Information Systems • Institute of Telematics • Institute of Software Technology and Programming Languages • Prof. Dr. Martin Leucker • Prof. Dr. rer. nat. habil. Ralf Möller • Prof. Dr. Stefan Fischer			
Language: • English, except in case of e	only German-speaking participants		



CS5700 - Case study in professional product development (Fallstudie)				
Duration:	Turnus of offer:	Credit points:	Max. group size:	
2 Semester	not available anymore	10 (Тур В)	12	
Course of study, spe Master Compt 	cific field and term: Iter Science 2012 (compulsory), interdiscipl	inary competence, 2nd and 3rd sem	lester	
Classes and lectures Project Manag Product Devel	: Jement (seminar, 2 SWS) opement (team work, 8 SWS)	 Workload: 150 Hours group work 100 Hours private studies 30 Hours written report 20 Hours oral presentation (including preparation) 		
Contents of teaching • • • • • • • • •	g:			
Qualification-goals/ • • • Grading through: • continuous, su	Competencies: Iccessful participation in course			
Responsible for this • Studiengang: Teacher: • Institutes of th • Alle prüfungs	module: sleitung Informatik le Department of Computer Science/ Engin sberechtigten Dozentinnen/Dozenten des S	eering itudienganges		
Language: • English, excep	t in case of only German-speaking participa	ints		



CS5	CS5820-KP04, CS5820 - Legal foundations for IT (ITRecht)		
Duration:	Turnus of offer:		Credit points:
1 Semester	not available anymore		4 (Тур В)
Course of study, specific field and ter Master Interdisciplinary Courses Master Medical Informatics 2014 Master MES 2014 (optional subj Bachelor MES 2014 (optional su Master Computer Science 2012	m: (optional subject), Interdiscipli 4 (optional subject), interdiscipl ect), no specific field, 1st or 2nc bject), no specific field, Arbitrar (optional subject), interdisciplir	nary modules, Arbitrary sei inary competence, 1st or 2 I semester y semester nary competence, 3rd seme	mester nd semester ester
Classes and lectures:		Workload:	
 Legal Foundations for IT (lecture Legal Foundations for IT (semin 	 Legal Foundations for IT (lecture, 1 SWS) Legal Foundations for IT (seminar, 1 SWS) 55 Hours private studies 45 Hours in-classroom work 20 Hours exam preparation 		studies sroom work preparation
Contents of teaching:			
 Introduction and Overview Personality rights, freedom of th Regulatory objectives: informat Youth protection and self-regul Privacy and Data Protection Press and advertising law Copyright, trademark, patent la German Data Protection Act (TE Agreement(MDStV) Contract law and e- contracting International aspects Case Studies Summary and Outlook 	ie press and the media, and fre on and law ation W)G) and Teleservice Data Protec	edom of speech tion Act(TDDSG), Signature	e Act (SigG), German Interstate Media Services
Qualification-goals/Competencies: • The students know the legal ba • The students know the legal ba	sis for the production and use of sis for the operation of IT and c	of software and digital mec ommunications systems.	lia.
Grading through: • Written or oral exam as announ	ced by the examiner		
Responsible for this module: Studiengangsleitung Informati Teacher: external institution externe Lehrbeauftragte Literature: : : : 	k		
Language: • English, except in case of only G	erman-speaking participants		



CS5840-KP04, CS5840 - Seminar in English (SemiEngl)			
Duration:	Turnus of offer:		Credit points:
1 Semester	each semester		4 (Тур В)
Course of study, specific field a Master Artificial Intelliger Master Computer Science Master Computer Science Master Computer Science	and term: nce 2023 (optional subject), for equ e 2019 (optional subject), interdisci e 2014 (optional subject), interdisci e 2012 (optional suject), interdiscip	ivalence check, Arbitrary plinary competence, Arb plinary competence, Arb linary competence, Arbit	r semester itrary semester itrary semester rrary semester
Classes and lectures: • Seminar in Englisch (sem	tures:Workload:in Englisch (seminar, 2 SWS)• 90 Hours work on an individual topic with written and o presentation • 30 Hours in-classroom work		rork on an individual topic with written and oral ภา h-classroom work
Contents of teaching: • Familiarization in a dema • Working on a scientific to • Presentation and discuss	anding scientific topic opic and its answers for problems c ion of the topic in English	on their own	
Qualification-goals/Competen The students can obtain They can review a scient They are able to present The can present and disc They can follow a scienti 	cies: a solid grounding a demanding sci ific work. the results in a written documenta uss a scientific topic in English. fic presentation and assess critically	entific topic. tion and in a talk in an u y in an open discussion.	nderstandable way.
Grading through: • oral presentation • Written report			
Responsible for this module: • Studiengangsleitung Int Teacher: • Institutes of the Departm • Alle prüfungsberechtigt	formatik ient of Computer Science/ Enginee en Dozentinnen/Dozenten des Stu	ring dienganges	
Literature: • is selected individually: Language:			
 offered only in English 			
Notes: Prerequisites for attending - None Prerequisites for the exam: - Successful participation ir	the module: • the seminar incl. elaboration, pres	entation, contributions t	to the discussion according to the requirements at
the beginning of the seme Module exam(s): CS5840-L1: English Langua Registration and topic assic	ster. ge Seminar, Seminar, 100% of (non gnment in a preliminary meeting at	existent) module grade. t the end of the precedin	g semester.



PS5810-KP04, PS5810 - Scientific Teaching and Tutoring (WLehrKP04)			
Duration:	Turnus of offer:		Credit points:
1 Semester	irregularly		4 (Тур В)
 Course of study, specific field and term: Bachelor Interdisciplinary Courses for health sciences (optional subject), interdisciplinary competence, Arbitrary semester Master Computer Science 2019 (optional subject), interdisciplinary competence, Arbitrary semester Master Entrepreneurship in Digital Technologies 2020 (optional subject), interdisciplinary competence, Arbitrary semester Master Interdisciplinary Courses (optional subject), Interdisciplinary modules, Arbitrary semester Bachelor Interdisciplinary Courses (optional subject), Interdisciplinary modules, Arbitrary semester Bachelor Interdisciplinary Courses (optional subject), Interdisciplinary modules, Arbitrary semester Baster CLS 2016 (optional subject), Interdisciplinary modules, 3rd semester Master Entrepreneurship in Digital Technologies 2014 (optional subject), interdisciplinary competence, Arbitrary semester Master Media Informatics 2014 (optional subject), interdisciplinary competence, Arbitrary semester Master MES 2014 (optional subject), no specific field, 1st or 2nd semester Bachelor MES 2014 (optional subject), no specific field, Arbitrary semester Master Computer Science 2014 (optional subject), interdisciplinary competence, Arbitrary semester Master Computer Science 2014 (optional subject), interdisciplinary competence, Arbitrary semester Master Computer Science 2014 (optional subject), interdisciplinary semester Master CLS 2010 (optional subject), no specific field, Arbitrary semester Master CLS 2010 (optional subject), interdisciplinary competence, Arbitrary semester Master Computer Science 2014 (optional subject), interdisciplinary competence, Arbitrary semester Master CLS 2010 (optional subject), interdisciplinary competence, 3rd semester Master Computer Science 2012 (optional subj			
Classes and lectures:		Workload:	
 Theory and Practice of Good Te Work as a tutor in a lecture (pressure) 	eaching (seminar, 1 SWS) actical course, 2 SWS)	 60 Hours private 45 Hours oral pr 15 Hours in-class 	e studies and exercises esentation (including preparation) sroom work
Contents of teaching: • Organizing and running a scient • Basic didactics of scientific teach • Practical work in tutorials	ntific lecture ching		
 Qualification-goals/Competencies: The participants are able to lead a student working group and to communicate technical issues to it appropriately. Basic pedagogical and didactical skills 			
Grading through: • continuous participation in all	courses of the module		
Responsible for this module: • Prof. Dr. rer. nat. Nico Bunzeck • Prof. Dr. rer. nat. Jürgen Prestin Teacher: • Institute for Mathematics • PD Dr. rer. nat. Jörn Schnieder • Alle prüfungsberechtigten Dozentinnen/Dozenten des Studienganges • Corinna Lütsch			
Language: • depends on the chosen course	s		
Notes:			
The seminar must be attended b	efore working as a tutor. This a	ctivity cannot be remunerat	ed.
The course instructor in charge o	f the respective course will issu	e a certificate of achieveme	nt for the module.



PS5830-KP04, PS5830 - Start-up and New Business (StartUp)			
Duration:	Turnus of offer:		Credit points:
1 Semester	not available anymore		4 (Тур В)
Course of study, specific Master Media Infor Bachelor Robotics a Master Medical Infor Master MES 2014 (c Bachelor MES 2014 Master Computer S Bachelor MES 2011 Bachelor Computer Master CLS 2010 (o Master Computer S	field and term: matics 2014 (optional subject), Interdiscip and Autonomous Systems 2016 (optional ormatics 2014 (optional subject), interdisc optional subject), no specific field, 1st or 2 (optional subject), no specific field, Arbit ficience 2014 (optional subject), interdiscip (optional subject), interdisciplinary comp r Science 2014 (optional subject), central to ptional suject), interdisciplinary compete icience 2012 (optional subject), interdiscip	olinary modules, Arbitrary sem subject), interdisciplinary con iplinary competence, 1st or 2 and semester rary semester olinary competence, Arbitrary betence, Arbitrary semester topics of computer science, 51 nce, 2nd or 3rd semester olinary competence, 2nd or 31	nester npetence, 5th or 6th semester nd semester semester th or 6th semester rd semester
Classes and lectures		Workload:	
 Start-up and New E Start-up and New E 	Business (seminar, 1 SWS) Business (practical course, 1 SWS)	 45 Hours private 30 Hours in-class 30 Hours written 15 Hours oral press 	studies sroom work report esentation (including preparation)
 Entre-/ Intrapreneu Business Modelling Technology product Target groups, cust Sales channels, ma Key ressources / acc costs and financing special subjects: que Qualification-goals/Comp The students have They have acquired They are able to de They are able to as 	Irship I ct, value propositions, and customer bene tomer segments, and customer relations rketing and sources of income tivities / partners g, including funding programs lality, acceptance for trading, legal form c petencies: gained basic insights in the field of Start- d a sound knowledge of business modelli evelop a business plan based on a particu sess the chances and risks of a start-up ar	efit of organization, a.o. up, new product developmen ng and planing. lar project. nd new product / new busines	it and new business development. ss development.
Grading through: • contributions to the	e discussion		
Responsible for this mod Prof. Dr. Martin Leu Teacher: Institute of Softwar Dr. Raimund Mildne Literature:	l ule: icker re Technology and Programming Languag er	ges	
Aktuelle Forschung	jsartikel werden in der Veranstaltung bek	anntgegeben.:	
Language: • offered only in Geri	man		



CS5990-KP30, CS5990 - Master Thesis Computer Science (MasterInf)			
Duration:	Turnus of offer:	Credit points:	
1 Semester	each semester	30	
Course of study, specific field • Master Computer Scienc • Master Computer Scienc • Master Computer Scienc	and term: ce 2019 (compulsory), computer scie ce 2014 (compulsory), computer scie ce 2012 (compulsory), computer scie	nce, 4th semester nce, 4th semester nce, 4th semester	
Classes and lectures: • Master's Thesis (supervis • Colloquium (colloquium	 sses and lectures: Master's Thesis (supervised self studies, 1 SWS) Colloquium (colloquium, 1 SWS) Workload: 870 Hours research for and write up of a thesis 30 Hours oral presentation and discussion (including preparation) 		
Contents of teaching: • individual studies under	supervision		
 Qualification-goals/Competer The students are able to solve it within limited tin They are able to get acq to work out a solution a They can evaluate their Grading through:	ncies: • structure a comprehensive and cor me. Juainted with a problem int he field nd to document the solution in a wi solution critically and present it in a	nplex problem from the field of computer sciece or its applications and to of computer science in a detailed way, to analyse corresponding literature, itten thesis. talk and defend it in a scientific discussion.	
 oral presentation Written report 			
Responsible for this module: • Studiengangsleitung In Teacher: • Institutes of the Departn • Alle prüfungsberechtig	nformatik nent of Computer Science/ Enginee Iten Dozentinnen/Dozenten des Stu	ing dienganges	
Literature: • links will be given by the	e supervisor:		
Language: • thesis can be written in (German or English		
Notes: requirements for starting a	a master's thesis see Academic Regu	lations and Procedures for Students, e.g. at least 75 credit points	



CS3051-KP04, CS3051 - Parallel Computing (ParallelVa)			
Duration:	Turnus of offer:		Credit points:
1 Semester	normally each year in the	summer semester	4
Course of study, specific field and term: Bachelor Computer Science 2019 (op Bachelor Computer Science 2019 (op Bachelor Media Informatics 2020 (op Bachelor Robotics and Autonomous Bachelor Computer Science 2016 (op Bachelor Computer Science 2016 (op Bachelor Computer Science 2016 (op Bachelor Robotics and Autonomous Bachelor Robotics and Autonomous Bachelor IT-Security 2016 (optional s Master Medical Informatics 2014 (op Bachelor Computer Science 2014 (op Bachelor Computer Science 2012 (opti	otional subject), major subject), canonical S tional subject), Canonical S Systems 2020 (optional subject), Canonical S bitional subject), Canonical S otional subject), Canonical S Systems 2016 (optional subject), computer science, ubject), computer science, s tional subject), computer science, s tional subject), computer science, scienc	ect informatics, Arbitrary se pecialization SSE, 4th seme cience, 5th or 6th semester bject), computer science, 5 pecialization Web and Dat ect informatics, Arbitrary se pecialization SSE, 4th seme bject), computer science, 5t Arbitrary semester cience, 1st or 2nd semester cs of computer science, 5th riculum programming, 2nd	mester ester th or 6th semester a Science, 4th semester mester ester h or 6th semester h or 6th semester
Bachelor Computer Science 2012 (opti Master Computer Science 2012 (opti Master Computer Science 2012 (opti	onal subject), advanced cul otional subject), central topi onal subject), advanced cu	ics of computer science, 5th riculum algorithmics and c	h or 6th semester complexity theory, 2nd or 3rd semester
Classes and lectures:		Workload:	
 Parallel Computing (lecture, 2 SWS) Parallel Computing (exercise, 1 SWS) 		 65 Hours private 45 Hours in-classi 10 Hours exam place 	studies and exercises room work reparation
Contents of teaching:			
 Programming language support for Design methodologies for parallel al Implementation of parallel algorithm Parallel search and sorting Parallel graph algorithms Parallel formula evaluation Speedup, efficiency, parallel complete Limits of parallelism and lower bound 	parallel programming gorithms ns kity classes ds		
Qualification goals/Compatancies			
 Qualification-goals/Competencies: Studentes are able to describe the design and function of parallel systems. They are able to design and implement parallel algorithms. They are able to analyze parallel systems and programs. They are able to describe the limits of parallel systems. 			
Grading through:			
Viva Voce or test			
Requires:			
Theoretical Computer Science (CS20	00-KP08, CS2000)		
Prof. Dr. rer. nat. Till Tantau			
Teacher:			
Institute for Theoretical Computer So	ience		
• Prof. Dr. rer. nat. Till Tantau			
l itoraturo:	19		
Jaja: An Introduction to Parallel Algo	rithms - Addison Wesley, 19	992	



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

Language:

• offered only in German

Notes:

Admission requirements for taking the module:

- None (the competencies of the modules listed under



CS4003 - Computational Complexity (Komplex)			
Duration:	Turnus of offer:		Credit points:
1 Semester	not available anymore		4
Course of study, specific field and term: • Master Computer Science 2012 (opti • Master Computer Science 2012 (com • Master CLS 2010 (optional subject), o	ional subject), specializatic npulsory), advanced curric computer science, 2nd ser	on field IT security and safet ulum algorithmics and com nester	ry, 2nd or 3rd semester plexity theory, 2nd or 3rd semester
Classes and lectures: • Computational Complexity (lecture)	d lectures:Workload:nputational Complexity (lecture with exercises, 3 SWS)65 Hours private studies and exercises45 Hours in-classroom work10 Hours exam preparation		e studies and exercises sroom work preparation
Contents of teaching: structure of time and space classes comparison of different reducibilities circuit complexity probabilistic complexity classes Polynomial Hierarchy separation of complexity classes oracle Turing machines and relativisation 			
 Qualification-goals/Competencies: ability to classify problems according knowledge of relations between diff understanding of the terms diagonation 	g to various complexity m ferent machine models an lisation, simulation, confi <u>c</u>	easures d complexity measures guration graph, reductions a	and completeness, relativisation, and logical
Grading through: • Oral examination			
Requires: • Algorithmics (CS4000)			
Responsible for this module: • Prof. Dr. Rüdiger Reischuk Teacher: • Institute for Theoretical Computer Science • Prof. Dr. Rüdiger Reischuk • Prof. Dr. rer. nat. Till Tantau			
Literature: • : • : • : • : • : Language:			
English, except in case of only Germ	an-speaking participants		



CS4006 - Combinatorial Optimization (KombOpt)			
Duration:	Turnus of offer:	(Credit points:
1 Semester	not available anymore	2	4
Course of study, specific field and term:			
Master Computer Science 2012 (op	tional subject), advanced cu	rriculum algorithmics and co	mplexity theory, 2nd or 3rd semester
Classes and lectures: Workload:			
 Combinatorial Optimization (lecture, 2 SWS) Combinatorial Optimization (exercise, 1 SWS) Combinatorial Optimization (exercise, 1 SWS) 45 Hours in-classroom work 10 Hours exam preparation 		udies and exercises om work paration	
Contents of teaching: • • • •			
Qualification-goals/Competencies: • •			
Grading through: • Oral examination			
Requires: • Algorithmics (CS4000)			
Responsible for this module: • Prof. Dr. Rüdiger Reischuk Teacher: • Institute for Mathematics • Institute for Theoretical Computer S • Prof. Dr. Rüdiger Reischuk • PD Dr. rer. nat. Hanns-Martin Teiche	Science Prt		
Literature: • : • : • : • : • : • :			
Language: • offered only in German			



CS4008 - Advanced Algorithmics and Data Structures (AuD2)			
Duration:	Turnus of offer:		Credit points:
1 Semester	not available anymore		4
Course of study, specific field • Master Computer Science	and term: e 2012 (compulsory), advanced curri	culum algorithmics and comp	plexity theory, 2nd or 3rd semester
Classes and lectures: • Advanced Algorithmics	(lecture with exercises, 3 SWS)	cture with exercises, 3 SWS) • 65 Hours private studies and exercises • 45 Hours in-classroom work • 10 Hours exam preparation	
Contents of teaching: • • •			
Qualification-goals/Competer •	ncies:		
Grading through: • Oral examination			
Requires: • Algorithmics (CS4000)			
Responsible for this module: • Prof. Dr. Rüdiger Reischuk Teacher: • Institute for Theoretical Computer Science • Prof. Dr. Rüdiger Reischuk • Prof. Dr. rer. nat. Till Tantau			
Literature: • : • : • :			
Language: • English, except in case o	f only German-speaking participants		



CS4016 - Cryptology (Krypto)			
Duration:	Turnus of offer:		Credit points:
1 Semester	each winter semester		4
Course of study, specific field and term: • Master Computer Science 2012 (con • Master Computer Science 2012 (con • Master Computer Science 2012 (opt	npulsory), specialization fiel npulsory), advanced curricu ional subject), advanced cu	ld IT security and safety, 1s Ilum security, 2nd or 3rd se rriculum algorithmics and	t semester emester complexity theory, 2nd or 3rd semester
Classes and lectures: • Cryptology (lecture with exercises, 3	ises, 3 SWS) • 65 Hours private studies and exercises • 45 Hours in-classroom work • 10 Hours exam preparation		studies and exercises sroom work preparation
Contents of teaching: • • • • • • •			
Qualification-goals/Competencies: • • • • •			
Grading through: Viva Voce or test			
Responsible for this module: • Prof. Dr. Rüdiger Reischuk Teacher: • Institute for Theoretical Computer S • Prof. Dr. Rüdiger Reischuk • Prof. Dr. Maciej Liskiewicz	cience		
Literature: • : • : • : • : • : • : • : •			



CS4018 - Computer Algebra (CompAlgebr)			
Duration:	Turnus of offer: Credit points:		Credit points:
1 Semester	not available anymore		4
Course of study, specific field and term • Master CLS 2010 (optional suject) • Master Computer Science 2012 (c	1: , computer science, Arbitrary optional subject), advanced c	/ semester surriculum algorithmics and	complexity theory, 2nd or 3rd semester
Classes and lectures: • Computer Algebra (lecture with e	ecture with exercises, 3 SWS) • 65 Hours private studies and exercises • 45 Hours in-classroom work • 10 Hours exam preparation		studies and exercises sroom work preparation
Contents of teaching:			
• • • Polynome, Matrizen • Multiplikationsalgorithmen, FFT, I • Gr • formale Differentiation und	DFT		
Qualification-goals/Competencies: • • • •			
Grading through: • Oral examination			
Requires: • Algorithmics (CS4000)			
Responsible for this module: • Prof. Dr. Rüdiger Reischuk Teacher: • Institute for Theoretical Computer Science • Prof. Dr. Rüdiger Reischuk			
Literature:			
•:			
Language: • English, except in case of only Ge	rman-speaking participants		





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CS5010 - Wissenschaftliches Rechnen (ScienComp)				
Duration:	Turnus of offer:	Credit points:		
1 Semester	not available anymore	4		
Course of study, specific field • Master Computer Scien • Bachelor MES 2011 (op • Bachelor CLS 2010 (opt	d and term: Ice 2012 (optional subject), advanced cu tional subject), medical engineering scie ional subject), computer science, 6th se	rriculum algorithmics and complexity theory, 2nd or 3rd semester ence, 3rd, 5th, or 6th semester mester		
Classes and lectures: Workload:		Workload:		
 Scientific Computing (I Scientific Computing (e 	g (lecture, 2 SWS)• 65 Hours private studies and exercisesg (exercise, 1 SWS)• 45 Hours in-classroom work• 10 Hours exam preparation			
Contents of teaching: • lineare und nichtlineare • High-Performance Com • Modellierungsaspekte	e Gleichungssysteme, Eigenwertberechr nputing (Parallesierungstechniken)	ıungen		
Qualification-goals/Compete • Numerische Simulation • Anwendung auf praxisi	e ncies: 1 von naturwissenschaftlichen Vorgänge relevante Fragestellungen	n		
Grading through: • written exam				
Responsible for this module: • Prof. Dr. Rüdiger Reisch	uk			
Teacher:				
Institute for Theoretical Computer Science				
Prof. Dr. Rüdiger Reisch	uk			
Language: • offered only in German				



CS5099 -	Seminar Algorithmics and	d Complexity Theory	(SemAlgKomp)
Duration:	Turnus of offer:		Credit points:
1 Semester	not available anymore		4 (Тур В)
Course of study, specific field and t • Master Computer Science 201	erm: 2 (optional subject), advanced cu	ırriculum algorithmics and o	complexity theory, 2nd or 3rd semester
Classes and lectures: • Algorithmics (seminar, 2 SWS)		 Workload: 60 Hours work on an individual topic with written and oral presentation 30 Hours private studies 30 Hours in-classroom work 	
Contents of teaching: •			
Qualification-goals/Competencies: • •			
Grading through: • contributions to the discussion	n		
Requires: • Computational Complexity (C • Algorithmics (CS4000)	54003)		
Responsible for this module: • Prof. Dr. Rüdiger Reischuk Teacher: • Institute for Theoretical Comp • Prof. Dr. Rüdiger Reischuk • Prof. Dr. rer. nat. Till Tantau	uter Science		
Literature: • :			
Language: • English, except in case of only	German-speaking participants		



CS3052-KP04, CS30	52 - Programming La	anguages and Type S	ystems (ProgLan14)
Duration:	Turnus of offer:		Credit points:
1 Semester	each winter semester		4
Course of study, specific field and term: Bachelor Computer Science 2019 (op Bachelor Computer Science 2019 (co Bachelor Computer Science 2019 (co Bachelor Media Informatics 2020 (op Bachelor Media Informatics 2014 (op Bachelor Computer Science 2016 (co Bachelor Computer Science 2016 (co Bachelor Computer Science 2012 (co Bachelor Computer Science 2012 (co Master Computer Science 2012 (com Bachelor IT-Security 2016 (optional su Bachelor CLS 2010 (optional suject), co Bachelor Computer Science 2014 (op Bachelor Computer Science 2014 (op	tional subject), major subject), Canonical S mpulsory), Canonical Spectional subject), Canonical Spectional subject), computer s tional subject), computer s tional subject), major subject), major subject), canonical Spectional subject), central top mpulsory), Canonical Spectional subject), central top mpulsory), advanced curricu ubject), computer science, computer science, 5th or 6 tional subject), central top mpulsory), specialization fi	ect informatics, Arbitrary se Specialization Web and Dat ialization SSE, 3rd semester science, 5th or 6th semester ect informatics, Arbitrary se ialization SSE, 3rd semester ics of computer science, 5t feld IT security and safety, 4 lum programming, 2nd or Arbitrary semester th semester ics of computer science, 5t eld IT security and safety, 5	emester ta Science, 3rd semester r r r emester r h or 6th semester th semester 3rd semester h semester
Classes and lectures:		Workload:	
 Progamming Languages and Type Sy Progamming Languages and Type Sy 	vstems (lecture, 2 SWS) vstems (exercise, 1 SWS)	 60 Hours private 45 Hours in-class 15 Hours exam p 	studies and exercises room work reparation
 Overview on programming language Syntactic description of programmin Language elements for data structur Type systems for programming language Language elements for control struct Language elements for abstraction a Typing and type systems Semantics of programming language Language paradigms Language elements for concurrent p Tools for programming languages 	es g languages es uages cures nd modularization es		
Qualification-goals/Competencies: The students can characterize major They can understand, adapt and externation They can analyse the structure and p They can learn on their own and class They can argue on the support of typ The can evaluate possible programmed 	programming languages a end syntacic and semantic rinciples of programming sify new language elemen be systems for writing corre ing languages for an appli	ind can compare their appl descriptions of programmi languages. ts. ect programs. ication.	lication domains. ing languages.
Grading through: • Written or oral exam as announced b	y the examiner		
Requires: • Linear Algebra and Discrete Structure • Algorithms and Data Structures (CS10 • Introduction to Programming (CS100	es 1 (MA1000-KP08, MA100 001-KP08, CS1001) 0-KP10, CS1000SJ14))0)	
Responsible for this module: • Prof. Dr. Martin Leucker Teacher:			



Institute of Software Technology and Programming Languages
 Dr. Annette Stümpel Prof. Dr. Martin Leucker
.iterature:
 K.C. Louden: Programming Languages: Principles and Practice - Course Technology 2011 J.C. Mitchell: Concepts in Programming Languages - Cambridge University Press 2003 T.W. Pratt, M.V. Zelkowitz: Programming Languages: Design and Implementation - Prentice Hall 2000 R.W. Sebesta: Concepts of Programming Languages - Pearson Education 2012 R. Sethi: Programming Languages: Concepts and Constructs - Addison-Wesley 2003 D.A. Watt: Programming Language Design Concepts - John Wiley & Sons 2004 G. Winskel: The Formal Semantics of Programming Languages - MIT Press 1993
_anguage:
German and English skills required
Notes:
Admission requirements for taking the module: - None (the competencies of the modules listed under



CS4131 - Programming Methodology (MethoPrg)				
Duration:	Turnus of offer:	Credit points:		
1 Semester	not available anymore	4		
Course of study, specific field and term: • Master Computer Science 2012 (opt	ional subject), advanced ci	urriculum programming, 2nd or 3rd semester		
Classes and lectures: Workload:				
 Programming Methodology (lecture, 2 SWS) Programming Methodology (exercise, 1 SWS) 		 60 Hours private studies and exercises 45 Hours in-classroom work 15 Hours exam preparation 		
Contents of teaching:				
 Programming as a development pro- Transforming specifications into fun Improvement of functional algorithm Transforming functional algorithms Improvement of imperative program Data structure refinement Introduction of pointers and linked Transition to machine-oriented contor Methods for object-oriented program Techniques for abstraction and moco Advances programming techniques 	ocess actional algorithms ms into imperative programs ns data structures trol- and data strcutures mming fularization			
Qualification-goals/Competencies: Understanding the basic methods o Understanding major abstraction levents Proficiency in programming algorith Gaining deeper insight into the interes Familiarity with frequently used compared to the interest of the second se	f programming vels of programming nms with adequate langua rplay between control and rcepts for abstraction and i	ge elements data structures nodularization		
Grading through: • Written or oral exam as announced	by the examiner			
Responsible for this module: • Prof. Dr. Martin Leucker Teacher: • Institute of Software Technology and • Prof. Dr. Martin Leucker	d Programming Language	S		
Literature: • : • : • : • :				
Language: • English, except in case of only Germ	an-speaking participants			



CS4132 - Functional Programming (FunktPr)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	not available anymore		4	
Course of study, specific field and term: • Master Computer Science 2012 (op	tional subject), advanced cu	rriculum programming, 2nd	d or 3rd semester	
Classes and lectures:	Classes and lectures: Workload:			
 Functional Programming (lecture, 2 SWS) Functional Programming (exercise, 1 SWS) 		 60 Hours private studies and exercises 45 Hours in-classroom work 15 Hours exam preparation 		
Contents of teaching:				
 Overview on functional programm Elements of functional programming Recursive data structures Properties of functional programs Transformation of functional programs Abstraction and functional module Evaluation of functional programs Implementation of functional programs Functional input and output Lambda calculus and higher order 	ing languages ng ams s rams ming functions			
 Qualification-goals/Competencies: Knowing a functional programmine Familiarity with methods for functi Knowing important execution mode Ability to design well structured fu Understanding the relations between 	g language (SML, Haskell) onal programming lels of functional languages nctional programs for compl en functional and imperative	ex tasks e programming		
Grading through: • Written or oral exam as announced	by the examiner			
Responsible for this module: • Prof. Dr. Martin Leucker Teacher: • Institute of Software Technology ar • Prof. Dr. Martin Leucker	nd Programming Languages			
Literature: • : • : • : • : • : • :				
• English, except in case of only Gerr	nan-speaking participants			



	CS4133 - Logic Pro	gramming (LogikPr)
Duration:	Turnus of offer:	Credit points:
1 Semester	not available anymore	4
Course of study, specific field	and term:	
Master Computer Science	e 2012 (optional subject), advanced cu	rriculum programming, 2nd or 3rd semester
Classes and lectures:		Workload:
 Logic Programming (lecture, 2 SWS) Logic Programming (exercise, 1 SWS) 		 60 Hours private studies and exercises 45 Hours in-classroom work 15 Hours exam preparation
Contents of teaching:		
 Logic as a programming Introduction to logic pro Predicate logic resolutio Foundations of logic pro Data structures for logic Methods of logic progar Applications of logic prog Extensions of logic prog 	l language ogramming n ogramming programming nming ogramming amming	
 Qualification-goals/Competer Kowledge of a logic progenetic of a logic progenetic of a logic progenetic of the standing the foun Abitlity to design logic progenetic of the standing the application Understanding the exect 	ncies: gramming language dations of logic programming programs in a systematic way n areas of logic programming ution model of logic programs	
Grading through: • Written or oral exam as a	announced by the examiner	
Responsible for this module: • Prof. Dr. Martin Leucker Teacher: • Institute of Software Tec • Prof. Dr. Martin Leucker	hnology and Programming Languages	
Literature:		
• : • : • : • : • : Language:		
English, except in case o	f only German-speaking participants	



CS4135 - Programming Parallel and Distributed Systems (PPVS)					
Duration:	Turnus of offer:	Credit points:			
1 Semester	not available anymore	4			
Course of study, specific field and term: • Master Computer Science 2012 (op	; ptional subject), advanced cur	riculum programming, 2nd or 3rd semester			
Classes and lectures:		Workload:			
 Programming Parallel and Distributed Systems (lecture, 2 SWS) Programming Parallel and Distributed Systems (exercise, 1 SWS) 		 60 Hours private studies and exercises 45 Hours in-classroom work 15 Hours exam preparation 			
Contents of teaching:					
 Motivation of parallel and distribut Parallel hardware architectures Foundations of parallel programm Multithreaded programming Programming with compiler direct Synchronisation and mutual exclus Explicit communication through m Data parallel programming Analytical modelling Performance and evaluation 	ted processing ing tives sion nessage passing				
Qualification-goals/Competencies:					
 Kowledge of parallel computer arc Ability to design parallel and distri Experience in programming paralle Ability to use programming enviro Ability to evaluate sequential and 	hitectures buted software el and distributed systems nmentsfor parallel and distrib parallel implementations of a	uted programming program			
Grading through: • Written or oral exam as announced	d by the examiner				
Responsible for this module: • Prof. Dr. Martin Leucker Teacher: • Institute of Software Technology a • Prof. Dr. Martin Leucker	nd Programming Languages				
Literature:					
 : :<					
Language: • English, except in case of only Gerr	man-speaking participants				


CS5198 - Programming Lab (PrProgr)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	not available anymore		4 (Тур В)	
Course of study, specific field and term • Master Computer Science 2012 (co	: ompulsory), advanced curricu	ulum programming, 2nd or	3rd semester	
Classes and lectures:		Workload:		
Programming Lab (programming	project, 3 SWS)	75 Hours group45 Hours in-class	work sroom work	
Contents of teaching: • Implementing a model programm	Contents of teaching: Implementing a model programming language with functional, parallel and/or object-oriented language elements 			
 Qualification-goals/Competencies: Enhancing programming skills Undertanding advanced implementation techniques Ability to abstract from concrete programming languages 				
Grading through: • documentation				
Responsible for this module: • Prof. Dr. Martin Leucker Teacher:				
Prof. Dr. Martin Leucker				
 Language: English, except in case of only German-speaking participants 				



CS4019 - Theory of distributed systems (TVertSys)					
Duration:	Turnus of offer:	Turnus of offer:			
1 Semester	not available anymore		4		
Course of study, specific field ar • Master Computer Science	nd term: 2012 (optional subject), advanced cur	rriculum distributed inform	nation systems, 2nd or 3rd semester		
Classes and lectures:		Workload:			
Theory of Distributed System	 outed Systems (lecture with exercises, 3 SWS) 65 Hours private studies and exercises 45 Hours in-classroom work 10 Hours exam preparation 		studies and exercises room work reparation		
Contents of teaching: • • • • • • • • • •					
Qualification-goals/Competenci • • •	Qualification-goals/Competencies: • • •				
Grading through: • Oral examination					
Requires: • Algorithmics (CS4000)					
Responsible for this module: • Prof. Dr. rer. nat. Till Tantau Teacher: • Institute for Theoretical Co • Prof. Dr. rer. nat. Till Tantau • Prof. Dr. Rüdiger Reischuk	ม mputer Science ม				
Literature: • : • : • : • :					
Language: • English, except in case of c	only German-speaking participants				



CS4	4199 - Projektpraktikum Verte	eilte Informationssyste	me (PrVertfS)	
Duration:	Turnus of offer:		Credit points:	
1 Semester	irregularly		4 (Тур В)	
Course of study, specific field • Master Computer Science	and term: ce 2012 (compulsory), advanced curric	ulum distributed informatio	n systems, 2nd or 3rd semester	
Classes and lectures:Workload:• Projektpraktikum Verteilte Informationssysteme (practical course, 4 SWS)• 65 Hours • 45 Hours • 10 Hours		Workload: • 65 Hours private • 45 Hours in-class • 10 Hours written	studies room work report	
Contents of teaching: •				
Qualification-goals/Competer • •	ncies:			
Grading through: • programming project				
Responsible for this module: • Prof. Dr. Stefan Fischer Teacher: • Institute of Telematics • Institute of Information • Prof. Dr. Stefan Fischer • Prof. Dr. rer. nat. habil. R	Systems talf Möller			
Language: • offered only in German				



CS5153-KP04, CS5153 - Wireless Sensor Networks (DISensorN)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each summer semester		4	
Course of study, specific field and term: Master Media Informatics 2020 (opti Master Medical Informatics 2014 (opti Master Computer Science 2012 (opti Master Computer Science 2012 (opti Master Computer Science 2012 (opti	onal subject), computer sci otional subject), computer s ional subject), specializatior onal subject), advanced cur ional subject), advanced cu	ence, Arbitrary semester cience, 1st or 2nd semester n field IT security and safety riculum parallel and distribu rriculum organic computin	, /, 3rd semester uted system architecutres, 2nd or 3rd semester g, 2nd or 3rd semester	
Classes and lectures:		Workload:		
 Wireless Sensor Networks (lecture, 2 Wireless Sensor Networks (exercise, 	2 SWS) 1 SWS)	 60 Hours private 45 Hours in-class 15 Hours exam p 	studies room work reparation	
 Basics of Sensor Networks Architecture of Sensor Nodes and of Sensor Networks Identities and addressing Wireless communication Data management and topology control Time Synchronization Localization Energy harvesting 				
 Qualification-goals/Competencies: The students are able to present the They are able to cope with analysis, They are able to interpret and pursu 	 Qualification-goals/Competencies: The students are able to present the potential, benefits and limitations of sensor networks. They are able to cope with analysis, design, and evaluation of protocols in sensor networks. They are able to interpret and pursue current research activities for sensor networks. 			
Grading through:				
Oral examination				
Responsible for this module: • Prof. DrIng. Mladen Berekovic Teacher: • Institute of Computer Engineering				
 Literature: H. Karl, A. Willig: Protocols and Architectures of Wireless Sensor Networks - Wiley, 2005 F. Zhao, L. Guibas: Wireless Sensor Networks - Morgan Kaufmann, 2004 BC. Renner: Sustained Operation of Sensor Nodes with Energy Harvesters and Supercapacitors - Books on Demand 2013 				
Language:				
offered only in English				
Notes:				



Admission requirements for taking the module: - None

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

Module Exam(s):

- CS5153-L1: Wireless Sensor Networks, oral exam, 100% of the module grade



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CS	5192 - Practical Parallel and Dist	ributed System Architectures (PrPVS)
Duration:	Turnus of offer:	Credit points:
1 Semester	not available anymore	4 (Тур В)
Course of study, specific fie • Master Computer Scie	eld and term: ence 2012 (compulsory), advanced curric	ulum parallel and distributed system architecutres, 2nd or 3rd semester
Classes and lectures:Workload:• Practical Parallel and Distributed System Architectures (programming project, 3 SWS)• 65 Hours private studies • 45 Hours group work • 10 Hours written report		 Workload: 65 Hours private studies 45 Hours group work 10 Hours written report
Contents of teaching: • Solution of an applica	ation problem with parallel / distributed	systems in teamwork
Qualification-goals/Compe • In-depth understandi • Capability to use para • Ability for documenta	tencies: ng of the functionality and practical app allel and distributed systems for typical a ation and presentation of project results	lication of parallel and distributed system architectures pplication problems in teamwork
Grading through: • documentation		
Requires: • Distributed Systems (CS4150)	
Responsible for this module Prof. Dr. Stefan Fische Teacher: Institute of Telematics Institute of Computer Prof. DrIng. Mladen I Prof. Dr. Stefan Fische	e: er s Engineering Berekovic er	
Language: • offered only in Germa	ın	



	CS5154 - Swarm Intelligence (SwarmIntel)		
Duration:	Turnus of offer:		Credit points:
1 Semester	not available anymore		4
Course of study, specific field and term: • Master Computer Science 2012 (opti	onal subject), advanced cur	riculum organic computin	g, 2nd or 3rd semester
Classes and lectures: • Swarm Intelligence (lecture, 2 SWS) • Swarm Intelligence (exercise, 1 SWS)	Workload:SWS)65 Hours private studiesSWS)45 Hours in-classroom work10 Hours exam preparation		studies room work reparation
Contents of teaching: • • • • • • • • • • • • •			
• Grading through: • programming project			
Responsible for this module: • Prof. DrIng. Mladen Berekovic Teacher: • Institute of Computer Engineering • Prof. Dr. rer. nat. Walter Raasch			
Literature: • Eric Bonabeau, Marco Dorigo, Guy Tl	heraulaz: Swarm Intelligenc	e: From Natural to Artificia	l Systems - Oxford: OUP 1999
Language: • offered only in German			



CS5175 - Seminar Organic Computing (SemOrgComp)			
Duration:	Turnus of offer:		Credit points:
1 Semester	not available anymore		4 (Тур В)
Course of study, specific field a Master Computer Science 	and term: 2012 (optional subject), advanced	curriculum organic computi	ng, 2nd or 3rd semester
Classes and lectures: • Organic Computing (sem	asses and lectures: Workload: • Organic Computing (seminar, 2 SWS) • 60 Hours private studi • 30 Hours in-classroom • 20 Hours written repo • 10 Hours oral presenta		e studies ssroom work n report resentation (including preparation)
Contents of teaching: • Selected advanced topics	s in Organic Computing		
Qualification-goals/Competend • The students can master • They can familiarize them • They can summarize a sc • They can give an intelligi • ie haben die Kommunika Grading through:	c ies: basic scientific methodology. nselves with a scientific topic on the ientific topic in written form. ble and concise oral presentation o tionskompetenz, ein aktuelles Forse	eir own. f a current research topic. chungsthema in einer Frager	runde zu diskutieren.
Oral presentation and wr	itten report		
Responsible for this module: Prof. DrIng. Thilo Pionte Prof. DrIng. Erhardt Bart Prof. Dr. Stefan Fischer Prof. Dr. rer. nat. Thomas Teacher: Institute for Neuro- and B Institute of Telematics Institute of Computer Eng Prof. DrIng. Thilo Pionte Prof. Dr. rer. nat. Thomas Prof. Dr. Stefan Fischer Prof. DrIng. Erhardt Bart	ck (Nachfolger NN) h Martinetz ioinformatics gineering ck (Nachfolger NN) Martinetz h		
Language: • offered only in English			



CS5197 - Practical Course Organic Computing (PrOrganicC)					
Duration:	Turnus of offer: Credit points:				
1 Semester	not available anymore	4 (Тур В)			
Course of study, specific field and ter • Master Computer Science 2012	m: (compulsory), advanced curricu	lum organic computing, 2nd or 3rd semester			
Classes and lectures:Workload:• Practical Course Organic Computing (practical course, 3 SWS)• 90 Hours group work• 30 Hours in-classroom work					
Contents of teaching: In-Door Monitoring with Sensor Swarm Behaviour of Autonomo Image Recognition using conce	Contents of teaching: • In-Door Monitoring with Sensor Networks • Swarm Behaviour of Autonomos Robots • Image Recognition using concepts of OC				
Qualification-goals/Competencies: Detailed Knowledge of Methods Practical Experience with Progra 	s of Organic Computing by appl amming and Evalutation of Lear	lying ned Concepts of OC			
Grading through: • continuous, successful participa	tion in practical course, >80%				
Responsible for this module: • Prof. DrIng. Thilo Pionteck (Nachfolger NN) Teacher: • Institute of Telematics • Institute of Computer Engineering • Institute for Neuro- and Bioinformatics • Prof. DrIng. Thilo Pionteck (Nachfolger NN)					
Literature: • :					
Language: • offered only in German					



CS5193 - Practical Intelligent Embedded Systems (PrIntelES)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	not available anymore		4 (Тур В)	
Course of study, specific field and term: • Master Computer Science 2012 (cor	npulsory), advanced curricul	um intelligent embedded	systems, 2nd or 3rd semester	
Classes and lectures:Workload:• Practical Intelligent Emedded Systems (practical course, 3 SWS)• 65 Hours private studies • 45 Hours group work • 10 Hours written report		studies vork report		
Contents of teaching: • Realiziation of intelligent embedde	d systems for typical applicat	tion scenarios in teamwork	(
 Qualification-goals/Competencies: Students have gained in-depth knowledge about intelligent embedded systems and their practical applications. They are able to realize intelligent embedded systems in teamwork. They are able to document and present project results. 				
Grading through: • documentation				
Requires: • Real-Time Systems (CS4160)				
Responsible for this module: • Prof. Dr. rer. nat. Thorsten Buzug • Prof. DrIng. Mladen Berekovic • Prof. DrIng. Alfred Mertins Teacher: • Institute of Medical Engineering • Institute for Signal Processing • Institute of Computer Engineering • Prof. Dr. rer. nat. Thorsten Buzug • Prof. DrIng. Alfred Mertins • Prof. DrIng. Mladen Berekovic				
Language:				



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CS5194 - Pra	ctical Project in Signa	II and Image Processing (PrBildSigv)		
Duration:	Turnus of offer: Credit points:			
1 Semester	not available anymore	4 (Тур В)		
Course of study, specific field and term: • Master Computer Science 2012 (cor	npulsory), advanced curricu	ulum signal and image processing, 2nd or 3rd semester		
Classes and lectures: • iRoom (practical course, 3 SWS)	Classes and lectures: Workload: • iRoom (practical course, 3 SWS) • 60 Hours group work • 40 Hours private studies • 20 Hours written report			
Contents of teaching: • Planning and realization of typical s	ignal processing applicatio	ns in a team		
Qualification-goals/Competencies: Students will have comprehensive I They are able to realize signal proce They have the communication com 	knowledge of using signal a essing systems in teamwork petency to document and	and image processing algorithms in practice. and in a self-directed manner. present project results.		
Grading through: • programming project				
Requires: • Signal processing (CS3100-KP04) • Image processing (CS3203)				
Responsible for this module: • Prof. DrIng. Alfred Mertins Teacher: • Institute for Signal Processing • Prof. DrIng. Alfred Mertins • MitarbeiterInnen des Instituts				
Language: • offered only in German				
Notes: Prerequisites for attending the modul - None	e:			
Prerequisites for the exam: - None				



CS4180-KP04, CS4	CS4180-KP04, CS4180 - Security in Networks and Distributed Systems (SicherNet)			
Duration:	Turnus of offer:		Credit points:	
1 Semester	not available anymore		4	
 Course of study, specific field and term: Bachelor Medical Informatics 2014 (optional subject), computer science, 5th or 6th semester Bachelor Computer Science 2014 (optional subject), central topics of computer science, 6th semester Bachelor Computer Science 2014 (compulsory), specialization field IT security and safety, 4th semester Bachelor Computer Science 2012 (compulsory), specialization field IT security and safety, 6th semester Master Computer Science 2012 (optional subject), advanced curriculum security, 2nd or 3rd semester Master Computer Science 2012 (optional subject) advanced curriculum enterprise IT. 2nd or 3rd semester 				
Classes and lectures:		Workload:		
 Security in Networks and Distribute Security in Networks and Distribute 	d Systems (lecture, 2 SWS) d Systems (exercise, 1 SWS)	60 Hours private45 Hours in-class15 Hours exam p	studies room work reparation	
Contents of teaching:				
 Contents of teaching: Fundamentals of network security Attacks Cryptology Acquire a basic understanding of formals and organizational aspects of network security (IT-Grundschutz, ITIL security) Acquire a basic understanding of formals and organizational aspects of network security (IT-Grundschutz, ITIL security) Integrity & Authentication, Authorization, and Accountability Key Distribution Certificates and Digital Signatures Protocols (Physical & Data-Link, Network & Transport, Application Layer) Firewalls IT Grundschutz & ITIL Societal aspects Qualification-goals/Competencies: Acquire a basic understanding of security issues (important terms, security objectives, communication models, network security models, attacker models, difference between safety and security) Understand the different types of attacks and distributed systems Learn about the different types of attacks and distributed systems Learn about the different types of stacks and their classification Understand the basics of cryptography: substitution ciphers (Caesar, Vigenère, etc.), Enigma, One-Time Pad, stream ciphers (structure, RC4), block ciphers (Feistel Networks, DE5, AE5), operation modes (ECB, CBC, PCBC, CFB, OFB, Counter), padding, asymmetric systems (Diffie-Hellmann, RSA) Understand integrity, authentication, authorization, and accountability Understanding indigital certificates, public key infrastructures and learn about important standards such as X.509 Lean about important security solutions on different layers of the ISO/OSI stack Understand firewalls 				
 Grading through: Written or oral exam as announced by the examiner 				
Responsible for this module:				
Teacher:				
Institute of Telematics				
Prof. Dr. Stefan Fischer				
 Literature: William Stallings: Cryptography and Network Security: Principles and Practice - Prentice Hall, 2013 				



• William Stallings, Lawrie Brown: Computer Security: Principles and Practice - Prentice Hall, 2014

Language:

offered only in German



CS5015 - Seminar Security (SemSicher)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	not available anymore		4 (Тур В)	
Course of study, specific field and term: • Master Computer Science 2012 (op • Master Computer Science 2012 (op	tional subject), specializatio tional subject), advanced cu	n field IT security and safety, rriculum security, 2nd or 3rd	3rd semester semester	
Classes and lectures: Workload: • Seminar Security (seminar, 2 SWS) • 90 Hours work on an individual topic with write presentation • 30 Hours in-classroom work		an individual topic with written and oral om work		
Contents of teaching: •				
Qualification-goals/Competencies: • •				
Grading through: • Oral presentation and written repo	rt			
Responsible for this module: • Prof. Dr. Rüdiger Reischuk Teacher: • Institute of Computer Engineering • Institute of Telematics • Institute for Theoretical Computer S • Prof. Dr. Maciej Liskiewicz • Prof. Dr. Stefan Fischer • Prof. DrIng. Mladen Berekovic	Science			
Literature: • :				
Language: • English, except in case of only Germ	nan-speaking participants			



CS4157 - Mainframes: Architecture and Programming (Mainframes)					
Duration:	Turnus of offer:	Credit points:			
1 Semester	not available anymore	4			
Course of study, specific fiel • Master Computer Scie	d and term: nce 2012 (optional subject), advanced cu	rriculum enterprise IT, 2nd or 3rd semester			
Classes and lectures: • Mainframes: Archtectu • Mainframes: Archtectu	Classes and lectures:Workload:• Mainframes: Archtecture and Programming (lecture, 2 SWS)• 60 Hours private studies• Mainframes: Archtecture and Programming (exercise, 1 SWS)• 45 Hours in-classroom work• 15 Hours exam preparation				
Contents of teaching: Introduction into Mair Introduction into z/OS Application Programm System Programming Application Programs	nframe Architectures ning in z/OS in z/OS on Mainframes				
Qualification-goals/Compet • The students are famil • They know the most in • They are able to progr • They know the most in	encies: iar with the mainframe architecture. mportant characteristics and ways of usa am simple system and application progr mportant application programs on mainf	ge of the operating system z/OS. ams. rames, such as databases or web application servers.			
Grading through: • written exam					
Responsible for this module • Prof. Dr. Stefan Fischer Teacher: • Institute of Telematics • Prof. Dr. Stefan Fischer	:				
Literature: • :					
Language: • offered only in Germa	n				



CS5152 - SOA Technologies (SOA)				
Duration:	tion: Turnus of offer: Credit points:		Credit points:	
1 Semester	not available anymore		4	
Course of study, specific field and te • Master Computer Science 2012	rm: (optional subject), advanced cu	urriculum enterprise IT, 2nd	or 3rd semester	
Classes and lectures: • SOA Technologies (lecture, 2 SWS) • SOA Technologies (exercise, 1 SWS)		Workload: • 45 Hours in-classroom work • 45 Hours private studies • 30 Hours exam preparation		
Contents of teaching: SOA Overview Service-oriented organization Basics of Web Services Basic infrastructures for Web Se Business Process Execution Lan Transactions Security SOA in the context of sensor ne Alternative implementation tec SOA in medical technologies	ervices iguage (BPEL) etworks :hnologies			
Qualification-goals/Competencies: • The students can explain die m • They are familiar with the parad • They are able to analyze a busin • They can design and implement	ost important architectures for digm of service orientation. ness application with repsect to nt business applications based o	business applications in the o their realizability with SOA on web service technologies	e Internet. . technologies. 5.	
Grading through: • Written or oral exam as annour	nced by the examiner			
Responsible for this module: • Prof. Dr. Stefan Fischer Teacher: • Institute of Telematics • Prof. Dr. Stefan Fischer				
Literature: I. Melzer et.al.: Service-Orientier J. Dunkel, A. Eberhart, S. Fische Language: offered only in German 	rte Architekturen mit Web Servi r, C. Kleiner, A. Koschel: Enterpr	ices - Spektrum-Verlag 2010 ise SOA - Hanser-Verlag 200))8	



CS5191 - Seminar Enterprise IT (SemEnterIT)				
Duration:	Turnus of offer:	Credit points:		
1 Semester	not available anymore	4 (Тур В)		
Course of study, specific field and te • Master Computer Science 2012	e rm: 2 (optional subject), advanced cu	rriculum enterprise IT, 2nd or 3rd semester		
Classes and lectures: • Seminar Enterprise IT (seminar, 2 SWS)		 Workload: 60 Hours private studies 30 Hours written report 20 Hours in-classroom work 10 Hours oral presentation (including preparation) 		
Contents of teaching: • Current topics from the field or	f enterprise applications			
 Qualification-goals/Competencies: The students know and unders They are able to prepare and g 	stand current problems in the fie ive scientific talks and they are a	ld of enterprise applications. ble to write scientific summaries of existing papers and books.		
Grading through: • term paper				
Responsible for this module: • Prof. Dr. Stefan Fischer Teacher: • Institute of Information System • Institute of Telematics • Prof. Dr. Stefan Fischer	15			
Literature: • : Current scientific work				
 Language: English, except in case of only German-speaking participants 				



CS5196 - Projektpraktikum Enterprise IT (PrEnterpIT)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	not available anymore	4	4 (Тур В)	
Course of study, specific field and to • Master Computer Science 201	erm: 2 (compulsory), advanced currie	culum enterprise IT, 2nd or 3rd	semester	
Classes and lectures: • Projektpraktikum Enterprise IT (practical course, 3 SWS)		Workload:75 Hours group work45 Hours in-classroom work		
Contents of teaching: • Team-based solution of a maji and leading to the actual depl	or programming assignment fro oyment. Typically, solutions wil	om the area of enterprise softw II be SOA- or N-Tier-based.	are, starting from requirements analysis	
 Qualification-goals/Competencies: After the course, the participa middleware technologies such They have a good idea on how They are able to assess the difference 	nts will be able to design, imple n as J2EE or MS .Net. v to tranfer the acquired knowl ferences of the diverse platforn	ement, and deploy complex diu edge to larger projects. ns and have learned how to selo	istributed applications based on current ct the best platform for a specific task.	
Grading through:				
programming project				
Responsible for this module: Prof. Dr. Stefan Fischer Teacher: Institute of Information System Institute of Telematics Prof. Dr. Stefan Fischer Prof. Dr. ror, pat, babil, Palf Mä	ns			
Offered only in German	ner			



MA4030-KP08, MA4030 - Optimization (Opti)				
Duration: Turnus of offer:		Credit points:		
1 Semester each summer semester			8	
 Course of study, specific field and term: Minor in Teaching Mathematics, Bachelor of Arts 2023 (compulsory), mathematics, 8th semester Bachelor CLS 2023 (compulsory), mathematics, 4th semester Master Auditory Technology 2022 (optional subject), mathematics, 2nd semester Master MES 2020 (optional subject), mathematics, 1 natural sciences, Arbitrary semester Bachelor Computer Science 2019 (optional subject), Extended optional subjects, Arbitrary semester Master Robotics and Autonomous Systems 2019 (optional subject), Additionally recognized elective module, Arbitrary semester Master Robotics and Autonomous Systems 2017 (compulsory), mathematics, 8th semester Master Auditory Technology 2017 (optional subject), advanced curriculum, Arbitrary semester Bachelor Computer Science 2016 (optional subject), advanced curriculum, Arbitrary semester Bachelor CLS 2016 (compulsory), mathematics, 1 natural sciences, Arbitrary semester Master MES 2011 (optional subject), mathematics, 2 natural sciences, Arbitrary semester Bachelor CLS 2016 (compulsory), mathematics, 1 natural sciences, Arbitrary semester Master MES 2011 (optional subject), mathematics, 2 natural sciences, Arbitrary semester Master Computer Science 2012 (optional subject), advanced curriculum numerical image processing, 2nd or 3rd semester Bachelor MES 2011 (optional subject), medical engineering science, 6th semester Master Computer Science 2012 (optional subject), advanced curriculum analysis, 2nd or 3rd semester Bachelor MES 2010 (compulsory), mathematics, 4th semester 				
Classes and lectures:		Workload:		
 Optimization (lecture, 4 SWS) Optimization (exercise, 2 SWS) 		 130 Hours private studies and exercises 90 Hours in-classroom work 20 Hours exam preparation 		
 Contents of teaching: Linear optimization (simplex method) Unconstrained nonlinear optimization (gradient descent, conjugate gradients, Newton method, Quasi-Newton methods, globalization) Equality- and inquality-constrained nonlinear optimization (Lagrange multipliers, active set methods) Stochastic methods for machine learning 				
Qualification-goals/Competencies: • Students can model real-life problems as optimization problems. • They understand central optimization techniques. • They can explain central optimization techniques. • They can compare and assess central optimization techniques. • They can implement central optimization techniques. • They can assess numerical results. • They can select suitable optimization techniques for practical problems. • Interdisciplinary qualifications: • Students can transfer theoretical concepts into practical solutions. • They are experienced in implementation. • They can think abstractly about practical problems.				
Grading through: • Written or oral exam as announced by the examiner				
Is requisite for: • Non-smooth Optimization and Analysis (MA5035-KP05)				
Requires: • Linear Algebra and Discrete Structur • Analysis 2 (MA2500-KP09) • Analysis 2 (MA2500-KP04, MA2500)	es 2 (MA1500-KP08, MA150)0)		



Responsible for this module:
Prof. Dr. rer. nat. Jan Modersitzki
Teacher:
Institute of Mathematics and Image Computing
 Prof. Dr. rer. nat. Jan Modersitzki Prof. Dr. rer. nat. Jan Lellmann
Literature:
 J. Nocedal, S. Wright: Numerical Optimization - Springer F. Jarre: Optimierung - Springer C. Geiger: Theorie und Numerik restringierter Optimierungsaufgaben - Springer
Language:
offered only in German
Notes:
Prerequisites for attending the module: - None (Familiarity with the topics of the required modules is assumed, but the modules are not a formal prerequisite for attending the course).
Prerequisites for the exam: - Examination prerequisites can be defined at the beginning of the semester. If preliminary work is defined, it must have been completed and positively evaluated before the first examination.
Examination: - MA4030-L1: Optimization, written examination (90 min) or oral examination (30 min) as decided by examiner, 100 % of final mark



MA4500-KP04	MA4500-KP04, MA4500 - Mathematical Methods in Image Processing (MatheBildv)				
Duration:	Turnus of offer:		Credit points:		
emester every second winter semester 4			4		
Course of study, specific field and a Master MES 2020 (optional su Master Medical Informatics 20 Master Medical Informatics 20 Master MES 2014 (optional su Master MES 2011 (optional su Master Computer Science 201 Master Computer Science 201 Master Computer Science 201 Master CLS 2010 (compulsory	term: bject), mathematics / natural s 019 (optional subject), medical 014 (optional subject), medical bject), mathematics / natural s bject), mathematics, 1st or 3rd 2 (optional subject), advanced turriculum), imaging systems, s 2 (compulsory), advanced curr), mathematics, 1st or 3rd sem	ciences, Arbitrary semest image processing, 1st or image processing, 1st or ciences, 1st or 3rd semes semester I curriculum imaging syst signal and image process riculum numerical image ester	er 2nd semester 2nd semester ter ems, 2nd or 3rd semester ing, 1st or 3rd semester processing, 2nd or 3rd semester		
Classes and lectures:		Workload:			
 Mathematics in Image Proces Mathematics in Image Proces 	sing (lecture, 2 SWS) sing (exercise, 1 SWS)	 65 Hours pr 45 Hours in 10 Hours ex 	ivate studies and exercises -classroom work am preparation		
 Image processing Digital images Operators in the spatial doma Operators in the Fourier dom Deblurring Total variation Segmentation Level-set methods Qualification-goals/Competencies: Students have a solid mather They can compare and assess They understand fundamenta They understand fundamenta They understand typical num They are able to implement fi Interdisciplinary qualification Students have advanced skill They can translate theoretica They are experienced in implement 	ain ain natical understanding of typica typical mathematical image p ematical methods for image processin al operators in image processin al discretization techniques. erical methods for image proce undamental numerical method s: s in modeling. concepts into practical solutio ementation.	al image processing meth rocessing methods. ocessing. ig. essing. Is for image processing.	nods.		
• They can think abstractly abo	ut practical problems.				
Written or oral exam as annot	unced by the examiner				
Is requisite for: • Calculus of Variations and Par	tial Differential Equations (MA	5034-KP04, MA5034)			
Requires: • Linear Algebra and Discrete S • Analysis 2 (MA2500-KP04, MA	tructures 2 (MA1500-KP08, MA 2500)	.1500)			
Responsible for this module: • Prof. Dr. rer. nat. Jan Modersit Teacher:	zki				



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Institute of Mathematics and Image Computing
 Prof. Dr. rer. nat. Jan Modersitzki Prof. Dr. rer. nat. Jan Lellmann
ature:
 Gonzales/Woods: Digital Image Processing - Prentice Hall, 2007 Russ: The Image Processing Handbook - CRC Press, 2011 Handels: Medizinische Bildverarbeitung - Vieweg+Teubner, 2009
juage:
German and English skills required
25:
Prerequisites for attending the module: - None (The competences of the required modules are required for this module, but the modules are not a prerequisite for admission).
Prerequisites for the exam: - Preliminary examinations can be determined at the beginning of the semester. If preliminary work has been defined, it must have been completed and positively assessed before the initial examination.



	MA5030-KP04, MA5030 - Im	age Registration (Bild	regist)	
Duration:	Turnus of offer:		Credit points:	
1 Semester	mester every second winter semester		4	
Course of study, specific fie Master MES 2020 (opt Master Medical Inform Master Medical Inform Master MES 2014 (opt Master Computer Scie Master MES 2011 (opt Master CLS 2010 (opti Master Computer Scie	eld and term: tional subject), mathematics / natural scier natics 2019 (optional subject), medical ima natics 2014 (optional subject), medical ima tional subject), mathematics / natural scier ence 2012 (optional subject), advanced cur tional subject), mathematics, 1st or 3rd ser vanced curriculum), imaging systems, sign ional subject), mathematics, 1st or 3rd ser ence 2012 (optional subject), advanced cur	ices, Arbitrary semester ge processing, 1st or 2nd se ge processing, 1st or 2nd se ices, 1st semester riculum imaging systems, 2r nester al and image processing, 1st nester riculum numerical image pro	mester mester nd or 3rd semester or 3rd semester ocessing, 2nd or 3rd semester	
Classes and lectures:		Workload:		
Image Registration (leImage Registration (e	ecture, 2 SWS) xercise, 1 SWS)	 65 Hours private st 45 Hours in-classro 10 Hours exam pre 	udies and exercises om work eparation	
 Parametric registratio Non-parametric regis Qualification-goals/Competing Students know the future They are able to trans They have experience Interdisciplinary qualities Students have advance They can translate the They are experienced They are experienced They are apperienced 	n tration and regularization strategies tencies: Indamental concepts in image registration slate concrete problems into suitable mode e with parametric and non-parametric regi ifications: ced skills in modeling. eoretical concepts into practical solutions. in implementation. ctly about practical problems.	els. stration problems.		
Grading through:	· · · · · · · · · · · · · · · · · · ·			
Written or oral exam a	as announced by the examiner			
Requires: • Linear Algebra and Di • Analysis 2 (MA2500-K	iscrete Structures 2 (MA1500-KP08, MA150 P04, MA2500)	0)		
Responsible for this module • Prof. Dr. rer. nat. Jan N Teacher: • Institute of Mathemat • Prof. Dr. Martin Leuck • Prof. Dr. rer. nat. Jan N	e: Nodersitzki cics and Image Computing er Aodersitzki			
Literature:				
 Goshtasby: 2D and 3E Modersitzki: Numeric Modersitzki: FAIR: Flex 	D Image Registration - Wiley 2005 al Methods for Image Registration - Oxforc xible Algorithms for Image Registration - S	l University Press 2004 IAM 2009		



Rohr: Landmark-Based Image Analysis - Kluwer 2001 Language: German and English skills required Notes: Prerequisites for attending the module: None (The competences of the required modules are required for this module, but the modules are not a prerequisite for admission).

Prerequisites for the exam:

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



MA5032-KP04, MA5032 - Numerical Methods for Image Computing (NumerikBV)				
Duration:	Turnus of offer:	Credit points:		
1 Semester each winter semester		4		
Course of study, specific field Master MES 2020 (option Master Medical Information Master MES 2014 (option Master Medical Information Master MES 2011 (option Master Computer Scient Master CLS 2010 (option	d and term: onal subject), mathematics / natural scie atics 2019 (optional subject), medical im onal subject), mathematics / natural scie atics 2014 (optional subject), medical im onal subject), advanced curriculum imag ace 2012 (optional subject), advanced cu nal subject), mathematics, 2nd or 4th se	ences, Arbitrary semester lage processing, 1st or 2nd semester ences, Arbitrary semester lage processing, 1st or 2nd semester ging systems, 2nd or 4th semester urriculum numerical image processing, 2nd or 3rd semester emester		
Classes and lectures:		Workload:		
 Numerical Methods for Image Computing (lecture, 2 SWS) Numerical Methods for Image Computing (exercise, 1 SWS) 65 Hours private studies and exercises 45 Hours in-classroom work 10 Hours exam preparation 		 65 Hours private studies and exercises 45 Hours in-classroom work 10 Hours exam preparation 		
Contents of teaching:				
 Grids and image repres Operators in spatial and Discrete Fourier Transfo JPEG Poisson equation and f Splitting methods Multigrid methods 	inite differences discretization			
Qualification-goals/Compete The students are familie They have experience i They can implement nu They understand select They can implement se Interdisciplinary qualifie Students have advance They can translate theo They are experienced in They can think abstract	encies: ar with fundamental numerical concept n realizing practical solutions. umerical algorithms on a computer. ted methods for solving large linear syst elected methods for solving large linear cations: ed skills in modeling. pretical concepts into practical solutions n implementation. tly about practical problems.	s in image computing. tems. systems.		
Grading through:				
Written or oral exam as	announced by the examiner			
Responsible for this module: • Prof. Dr. rer. nat. Jan Mo Teacher: • Institute of Mathematic	odersitzki ss and Image Computing			
 Prof. Dr. rer. nat. Jan Mo Prof. Dr. rer. nat. Jan Le 	odersitzki Ilmann			
Language: • German and English ski	ills required			
Notes:				



Prerequisites for attending the module:

- None (Familiarity with the topics of the required modules is assumed, but the modules are not a formal prerequisite for attending the course).

Prerequisites for the exam:

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

Examination:

- MA5032-L1: Numerical Methods for Image Computing, written examination (90min) or oral examination (30min) as decided by examiner, 100% of final mark





MA5034-KP04, MA5034 - Calculus of Variations and Partial Differential Equations (VariPDE)				
Credit points:				
ester 4				
es, Arbitrary semester je processing, 1st or 2nd semester es, Arbitrary semester mester je processing, 1st or 2nd semester nester iculum numerical image processing, 2nd or 3rd semester l and image processing, 2nd or 4th semester mester				
Workload:				
 65 Hours private studies and exercises 45 Hours in-classroom work 10 Hours exam preparation 				
 Functional-analytic foundations Direct methods in the calculus of variations The dual space, weak convergence, Sobolev spaces Optimality conditions Classification of partial differential equations and typical PDEs Fundamental solutions, maximum principle Finite elements for elliptical partial differential equations 				
al setting. and partial differential equations. tional problems. I setting.				
Grading through:				
Written or oral exam as announced by the examiner				



- Vogel: Computational Methods for Inverse Methods SIAM
- Aubert, Kornprobst: Mathematical Problems in Image Processing: Partial Differential Equations and the Calculus of Variations Springer
- Scherzer, Grasmair, Grossauer, Haltmeier, Lenzen: Variational Methods in Imaging Springer

Language:

• German and English skills required

Notes:

Prerequisites for attending the module:

- None (Familiarity with the topics of the required modules is assumed, but the modules are not a formal prerequisite for attending the course).

Prerequisites for the exam:

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

Examination:

- MA5034-L1: Calculus of Variations and Partial Differential Equations, written examination (90min) or oral examination (30min) as decided by examiner, 100% of final mark





MA4040-KP04, MA4040 - Numerics 2 (Num2)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each summer semester		4	
Course of study, specific field and term • Bachelor MES 2020 (optional subje • Bachelor MES 2014 (optional subje • Bachelor MES 2011 (optional subje • Master Computer Science 2012 (op • Minor in Teaching Mathematics, M	ect), mathematics / natural sc ect), mathematics / natural sc ect), medical engineering scie ptional subject), advanced cu laster of Education 2023 (con	iences, 3rd semester at th iences, 4th or 6th semeste nce, 6th semester rriculum analysis, 2nd or npulsory), mathematics, 2	ne earliest er 3rd semester ind semester	
Classes and lectures:		Workload:		
 Numerics 2 (lecture, 2 SWS) Numerics 2 (exercise, 1 SWS) Sumerics 2 (exercise, 1			e studies and exercises ssroom work preparation	
Contents of teaching:				
 Polynomial interpolation Hermite interpolation Approximation Numerical quadrature Qualification-goals/Competencies: Students know basic numerical techniques. They can transform a continuous problem into a discrete one. They can handle both stable and robust numerical algorithms competently. 				
Ihey can competently work on pr	actical tasks.			
Grading through: • written exam				
Requires: • Numerics 1 (MA3110-KP04, MA3110) • Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500) • Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000) • Analysis 2 (MA2500-KP04, MA2500) • Analysis 1 (MA2000-KP08, MA2000)				
Responsible for this module:				
Prof. Dr. rer. nat. Andreas Rößler				
Teacher:				
Prof. Dr. rer. nat. Andreas Rößler				
•••				
 M. Bollhöfer, V. Mehrmann: Numerische Mathematik - Vieweg (2004) P. Deuflhard, A. Hohmann: Numerische Mathematik I P. Deuflhard, F. Bornemann: Numerische Mathematik II - 3. Auflage, De Gruyter (2008) M. Hanke-Bourgeois: Grundlagen der Numerischen Mathematik und des Wissenschaftlichen Rechnens - 3. Aufl., Teubner (2009) H. R. Schwarz, N. Köckler: Numerische Mathematik - 6. Auflage, Teubner (2006) J. Stoer: Numerische Mathematik I - 10. Auflage, Springer (2007) J. Stoer, R. Bulirsch: Numerische Mathematik II - 5. Auflage, Springer (2005) A. M. Quarteroni, R. Sacco, F. Salieri: Numerical Mathematics - 2. Auflage, Springer (2006) 				
Language: • offered only in German				



Notes:

The lecture is identical to that in module MA4040-MML/Numerics 2

Prerequisites for attending the module:

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

Prerequisites for the exam:

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



MA4330-KP04, MA4330 - Biosignal analysis (BioSA)			
Duration:	Turnus of offer:		Credit points:
1 Semester	each summer semester		4
Course of study, specific field and ter Master MES 2020 (optional subj Master MES 2014 (optional subj Master MES 2011 (optional subj Master Computer Science 2012 Master CLS 2010 (compulsory),	r m: ect), mathematics / natural scie ect), mathematics / natural scie ect), mathematics, 2nd semest (compulsory), advanced curric mathematics, 2nd semester	ences, Arbitrary semester ences, Arbitrary semester er ulum analysis, 2nd semeste	er
Classes and lectures: • Biosignal analysis (lecture, 2 SWS) • Biosignal analysis (exercise, 1 SWS)		 Workload: 65 Hours private studies and exercises 45 Hours in-classroom work 10 Hours exam preparation 	
Contents of teaching: • Hilbert spaces • Fourier series and Fourier transf • generalized functions • discrete wavelet tranformation • least square techniques • application to biological and mo	formation edical data		
Qualification-goals/Competencies: • Students have deepened know • They master different methods • They have practical skills in the • They have skills in working with	ledges of the mathematical ba of one-dimensional signal anal application of these methods n Mathematica or MatLab	ckground of signal analysis ysis	5
Grading through: • written exam • Exercises			
Requires: • Analysis 2 (MA2500-KP04, MA25	500)		
Responsible for this module: • Nachfolge von Prof. Dr. rer. nat. Teacher: • Institute for Mathematics • Nachfolge von Prof. Dr. rer. nat. • Prof. Dr. rer. nat. Jürgen Prestin	Karsten Keller Karsten Keller		
Literature: • S. Mallat: A wavelet tour of sign • A. N. Kolmogorov, S.V. Fomin: R	al processing - Academic Press eelle Funktionen und Funktion	, 1998 Ialanalysis - Deutscher Verl	ag der Wissenschaften 1975
Language: • offered only in German			
Notes:			



Prerequisites for attending the module:

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

Prerequisites for the exam:

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





MA4410 - Approximation Theory (Approx)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	irregularly	irregularly 4		
Course of study, specific field a • Bachelor CLS 2010 (optio • Master Computer Science • Master CLS 2010 (optiona	and term: nal subject), mathematics, 5th or 6 2012 (optional subject), advancec Il subject), mathematics, Arbitrary s	th semester I curriculum analysis, 2nd or 3 semester	rd semester	
Classes and lectures:Workload:• Approximation theory (lecture, 2 SWS)• 65 Hours private studies and exercise• Approximation theory (exercise, 1 SWS)• 45 Hours in-classroom work• 10 Hours exam preparation		studies and exercises room work reparation		
Contents of teaching: Fundamentals of function Best approximation Linear methods, trigonor Theorems of Jackson and Moduli of continuity Singular integrals Theorem of BanachStei Interpolation methods Stability inequalities	nal analysis netric kernels I Bernstein nhaus			
Qualification-goals/Competent • Learning the basic princip • Understanding the relation • Knowledge of the basic a	c ies: oles of approximation theory onship between order of converge pproximation methods	nce and smoothness		
Grading through: • Written or oral exam as a	nnounced by the examiner			
Responsible for this module: • Prof. Dr. rer. nat. Jürgen F Teacher: • Institute for Mathematics • Prof. Dr. rer. nat. Jürgen F	restin restin			
Literature: P. L. Butzer, R. J. Nessel: F A. Schönhage: Approxim	ourier Analysis and Approximation ationstheorie - de Gruyter 1971	- Birkhäuser Verlag 1971		
Language: • English, except in case of	only German-speaking participant	s		





MA4430 - Approximation on Spheres (ApproxSph)			
Duration:	Turnus of offer:		Credit points:
1 Semester	irregularly		4
Course of study, specific fie • Bachelor CLS 2010 (op • Master Computer Scie • Master CLS 2010 (opti	Id and term: ptional subject), mathematics, 5th or 6t ence 2012 (optional subject), advanced onal subject), mathematics, Arbitrary s	h semester curriculum analysis, 2nd or 3 emester	rd semester
 Classes and lectures: Approximation on spheres (lecture, 2 SWS) Approximation on spheres (exercise, 1 SWS) 		 Workload: 65 Hours private studies and exercises 45 Hours in-classroom work 10 Hours exam preparation 	
Contents of teaching: • Polynomial systems o • Approximation metho • Fast algorithms • Scattered data	n spheres ods		
Qualification-goals/Comper • Learning the basic pri • Understanding the fu • Knowledge of the basic	tencies: inciples of approximation theory on sp nction systems on spheres sic approximation methods on spheres	heres	
Grading through: • Written or oral exam a	as announced by the examiner		
Responsible for this module • Prof. Dr. rer. nat. Jürge Teacher: • Institute for Mathema • Prof. Dr. rer. nat. Jürge	e: en Prestin tics en Prestin		
Literature: • V. Michel: Lectures or Birkhäuser Verlag, Bo • W. Freeden, T. Gerver Science Publication, C	Constructive Approximation - Fourier, ston, 2013 Is, and M. Schreiner: Constructive Appr Clarendon Press, 1998	Spline, and Wavelet Methods oximation on the Sphere (Wit	s on the Real Line, the Sphere, and the Ball - h Applica- tions to Geomathematics) - Oxford
Language: • English, except in case	e of only German-speaking participants	;	



MA4510 - Wavelet Theory (Wavelet)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	irregularly		4	
Course of study, specific field a • Master Computer Science • Master CLS 2010 (optional	nd term: 2012 (optional subject), advanced subject), mathematics, Arbitrary s	curriculum analysis, 2nd or 3 emester	rd semester	
Classes and lectures: • Wavelet Theory (lecture, 2 SWS) • Wavelet Theory (exercise, 1 SWS)		 Workload: 65 Hours private studies and exercises 45 Hours in-classroom work 10 Hours exam preparation 		
Contents of teaching: • Haar system • discrete Haar transformati • orthonormal wavelet base • Multiresolution Analysis • algorithms for reconstruct • multivariate generalizatio	ion 25 tion and decomposition ns			
Qualification-goals/Competenc • Kenntnis der Grundlagen • Verständnis von Anwendu • Arbeiten mit Wavelettooll	ies: der Waveletanalysis ungen in der Signalanalyse, poxen			
Grading through: • Written or oral exam as ar	nounced by the examiner			
Responsible for this module: • Prof. Dr. rer. nat. Jürgen Pr Teacher: • Institute for Mathematics • Prof. Dr. rer. nat. Jürgen Pr	restin restin			
Literature: • : • :				
Language: • offered only in German				



MA4340 - Selected methods of bioinformatics (StatBioinf)			
Duration:	Turnus of offer:	Credit points:	
1 Semester	irregularly	4	
Course of study, specific field a • Master Computer Science	nd term: 2012 (optional subject), advancec	l curriculum stochastics, 2nd or 3rd semester	
 Classes and lectures: Selected methods of bioinformatics (lecture, 2 SWS) Selected methods of bioinformatics (exercise, 1 SWS) 		 Workload: 65 Hours private studies 45 Hours in-classroom work 10 Hours exam preparation 	
Contents of teaching: • • • • • • •			
Qualification-goals/Competenc •	ies:		
Grading through: • Written or oral exam as ar	nounced by the examiner		
 Responsible for this module: Prof. Dr. rer. nat. Andreas a Teacher: Institute of Medical Biome Prof. Dr. rer. nat. Andreas a Prof. Dr. rer. biol. hum. Ink 	Ziegler etry and Statistics Ziegler e König		
Literature: • :			
Language: • offered only in German			


MA4610-KP04,	MA4610 - Stochastic	processes and modeli	ng (StochPrzMd)
Duration:	Turnus of offer:		Credit points:
1 Semester	normally each year in the	winter semester	4
Course of study, specific field and term: • Master MES 2020 (optional subject) • Master MES 2014 (optional subject) • Master Computer Science 2012 (op • Master CLS 2010 (compulsory), mat	, mathematics / natural scie , mathematics / natural scie tional subject), advanced cu hematics, 1st or 3rd semest	nces, Arbitrary semester nces, 1st or 2nd semester rriculum stochastics, 2nd o er	r 3rd semester
Classes and lectures: • Stochastic processes and modeling • Stochastic processes and modeling	(lecture, 2 SWS) (exercise, 1 SWS)	Workload: • 55 Hours private • 45 Hours in-class • 20 Hours exam p	studies and exercises room work reparation
Contents of teaching: • Conditional expectation • Stochastic processes • Filtrations • Martingales • Brownian motion			
Qualification-goals/Competencies: Students can name stochastic proc They have deepened the stochastic They can explain and apply basic ic 	esses on the basis of selecte way of thinking and can ex leas and concepts of stocha	d process classes and expla plain the evidence of the le stic analysis.	ain their properties. ecture.
Grading through: • written exam Requires:			
 Stochastics 2 (MA4020-MML) Stochastics 1 (MA2510-KP04, MA25 	10)		
Responsible for this module: Prof. Dr. rer. nat. Andreas Rößler Teacher: Institute for Mathematics Prof. Dr. rer. nat. Andreas Rößler 			
Literature: • : • : • loannis Karatzas, Steven E. Shreve: I	Brownian Motion and Stoch	astic Calculus - Springer Ve	rlag, 2nd edition, 1991
Language: • German and English skills required			
Notes: Prerequisites for attending the modu - None (The competences of the requ Prerequisites for the exam: - Preliminary examinations can be det completed and positively assessed be	le: ired modules are required fo termined at the beginning o fore the initial examination	or this module, but the mod of the semester. If prelimina	dules are not a prerequisite for admission). ry work has been defined, it must have been





MA	5610 - Selected stoch	astic processes (Stoch	Prz2)
Duration:	Turnus of offer:		Credit points:
1 Semester	not available anymore		4
Course of study, specific field and term: • Bachelor CLS 2010 (optional suject) • Master CLS 2010 (optional subject), • Master Computer Science 2012 (optional subject)	, mathematics, 6th semeste mathematics, 2nd or 4th se tional subject), advanced cu	r emester urriculum stochastics, 2nd o	r 3rd semester
Classes and lectures:Workload:• Selected stochastic processes (lecture, 2 SWS)• 65 Hours private studies• Selected stochastic processes (exercise, 1 SWS)• 45 Hours in-classroom work• 10 Hours exam preparation		studies room work reparation	
Contents of teaching: • branching processes • Poisson process • birth-and-death processes • reneval processes • Brownian and fractional Brownian r • life science applications	notion		
Qualification-goals/Competencies: Mastering some important classes of 	of stochastic processes and	understanding possible app	olications
Grading through: Oral examination 			
Requires: • Stochastics 2 (MA4020-KP04, MA40	20)		
 Responsible for this module: Prof. Dr. rer. nat. Andreas Ziegler Nachfolge von Prof. Dr. rer. nat. Kar Teacher: Institute of Medical Biometry and St Institute for Mathematics Nachfolge von Prof. Dr. rer. nat. Kar Prof. Dr. rer. nat. Andreas Ziegler 	sten Keller tatistics sten Keller		
Literature: • R. Durrett: Probability: Theory and E • S. Karlin und H.M. Taylor: A First Co	ixamples - 3rd. edition, Tho urse in Stochastic Processes	mson, 2005 s - 2rd. edition, Academic Pr	ess, 1975
Language: • offered only in German			



	MA5620 - Selected stat	istical models (StatModell)	
Duration:	Turnus of offer:	Credit points:	
1 Semester	not available anymore	4	
Course of study, specific field • Master Computer Science	and term: e 2012 (optional subject), advanced c	urriculum stochastics, 2nd or 3rd semester	
Classes and lectures: • Selected statistical mod • Selected statistical mod	els (lecture, 2 SWS) els (exercise, 1 SWS)	 Workload: 65 Hours private studies 45 Hours in-classroom work 10 Hours exam preparation 	
Contents of teaching: • • • •			
Qualification-goals/Competer •	ncies:		
Grading through: • Written or oral exam as	announced by the examiner		
Responsible for this module: • Prof. Dr. rer. nat. Andrea Teacher: • Institute of Medical Bion • Institute for Mathematic • Prof. Dr. rer. nat. Andrea	s Ziegler netry and Statistics s s Ziegler		
Literature: • :			
Language: • English, except in case c	of only German-speaking participants		



	CS4000 - Algo	orithmics (ALG)	
Duration:	Turnus of offer:		Credit points:
1 Semester	each winter semester		4
Course of study, specific field and term: • Master CLS 2010 (optional subject), o • Master Computer Science 2012 (com	computer science, 1st or 3rd pulsory), computer science	d semester e mandatory courses, 1st se	emester
Classes and lectures:		Workload:	
 Algorithmics (lecture, 2 SWS) Algorithmics (exercise, 1 SWS) 		 65 Hours private 45 Hours in-class 10 Hours exam p 	studies and exercises room work reparation
Contents of teaching:			
 satisfiability and constraint satisfacti randomized search discrete optimization problems, line Las-Vegas- and Monte-Carlo-algorith complexity analysis of algorithmic p approximation algorithms heuristic search 	on problems ar programming ims roblems		
Qualification-goals/Competencies:			
 ability to model real problems in an ability to design efficient algorithms good practice in applying basic algo skill in analyzing algorithms, in participation 	algorithmic manner for complex problems rithmic techniques cular with respect to corrre	ctness and complexity	
Grading through: • Viva Voce or test			
Is requisite for: • Seminar Algorithmics and Complexit • Advanced Algorithmics and Data Str • Computer Algebra (CS4018)	ry Theory (CS5099) uctures (CS4008)		
Requires:			
 Theoretical Computer Science (CS20 Algorithm Design (CS3000-KP04, CS3 	00-KP08, CS2000) 3000)		
Responsible for this module: Prof. Dr. Rüdiger Reischuk Teacher: Institute for Theoretical Computer So 	cience		
 Prof. Dr. Rüdiger Reischuk Prof. Dr. rer. nat. Till Tantau Prof. Dr. Maciej Liskiewicz 			
Literature:			
 Aho, Hopcroft, Ullman: Design and A Motwani, Raghavan: Randomized Al Mitzenmacher, Upfal: Probability and Kreher, Stinson: Combinatorial Algor Williamson, Shmoys: The Design of A 	Analysis of Computer Algori gorithms - Cambridge Univ d Computing - Cambridge I ithms - CRC Press, 1999 Approximation Algorithms	ithms - Addison Wesley, 19 rersity Press, 2000 Jniversity Press, 2005 - Cambridge University Pre	78 ss, 2011



Language:

• offered only in German



	CS4005 - Algorithmic Learning	and Data Mining (Al	gLernDM)
Duration:	Turnus of offer:		Credit points:
1 Semester	not available anymore		4
Course of study, specific field Master Computer Scier 	d and term: nce 2012 (compulsory), computer science i	mandatory courses, 2nd se	emester
Classes and lectures: • Algorithmic Learning a SWS)	nd Data Mining (lecture with exercises, 3	Workload: • 65 Hours private s • 45 Hours in-classr • 10 Hours exam pr	studies and exercises oom work reparation
Contents of teaching: • Concept learning • Learning in the limit • PAC-Learning • Decision tree learning • Naive Bayes Classifier • Instance based learning • Searching algorithms in	g n Data Mining		
Qualification-goals/Compete • Understanding of learr • Knowledge and unders • Knowledge of the basis • Ability to apply machir	encies: ning models standing of basic machine learning metho c methods in data mining ne learning and data mining methods to re	ds eal-life problems	
Grading through: • Written or oral exam as	announced by the examiner		
Requires: • Algorithmics (CS4000)			
Responsible for this module: • Prof. Dr. Maciej Liskiew Teacher: • Institute for Theoretica • Prof. Dr. Rüdiger Reisch • Prof. Dr. Maciej Liskiew	icz I Computer Science nuk icz		
Literature: • M.J. Kearns, V.V. Vazira • T.M. Mitchell: Machine • D. Hand, H.Mannila, P. • J. Han, M. Kamber: Dat	ni: An Introduction to Computational Lear Learning - WCB McGraw-Hill, 1997 Smyth: Principles of Data Mining - MIT Pre a Mining - Morgan Kaufmann 2001	ning Theory - MIT Press, 1 ss, 2001	997
Language: • English, except in case	of only German-speaking participants		





CS4020 - Specification and Modelling (SpezMod)			lod)
Duration:	Turnus of offer:		Credit points:
1 Semester	each winter semester		4
Course of study, specific field and term: • Master CLS 2010 (optional subject), o • Master Computer Science 2012 (com	computer science, Arbitrary ipulsory), computer science	semester mandatory courses, 1st se	mester
Classes and lectures:		Workload:	
 Specification and Modelling (lecture) Specification and Modelling (exercise) 	cture, 2 SWS)• 60 Hours private studies and exercisessercise, 1 SWS)• 45 Hours in-classroom work• 15 Hours exam preparation		studies and exercises room work reparation
Contents of teaching:			
 Introduction to modelling and speci- Modelling concepts (data, streams, t Modelling software components (state) Modelling concurrency Algebraic specification Composing, refining, analysing and tools for 	fication races, diagrams, tables) ate, behaviour, structure, int transforming specifications r specification and modellir	erface) and models ng	
Qualification-goals/Competencies: The students can argue on the impo Sie können wichtige Spezifikations- They can model and coefficients 	rtance of specifications and und Modellierungstechnike	l models for software deve n charakterisieren, anwenc	lopment. den, anpassen und erweitern.
 They can describe a system from diff They can apply specifications and m 	ferent views and on differer odelsin software developm	n an adequate way. nt levels of abstraction. ent.	
Grading through:			
Written or oral exam as announced by the examiner			
Responsible for this module:			
Prof. Dr. Martin Leucker			
Ieacher: Institute of Software Technology and	d Programming Languages		
Dr. Annette Stümpel	5 5 5 5		
Prof. Dr. Martin Leucker			
Literature:			
 V.S. Alagar, K. Periyasamy: Specificat M. Broy, K. Stølen: Specification and 	Ion of Software Systems - S Development of Interactive	pringer 2011 Systems - Springer 2001	
J. Loeckx, HD. Ehrich, M. Wolf: Specification of Abstract Data Types - John Wiley & Sons 1997			997
U. Kastens, H. Kleine Büning: Modelli	ierung - Grundlagen und fo	rmale Methoden - Hanser 2	2005
Language:			
German and English skills required			
Language: • German and English skills required			



	CS4150 - Distribute	ed Systems (VertSys)	
Duration:	Turnus of offer:		Credit points:
1 Semester	not available anymore		4
Course of study, specific field and term: • Master Computer Science 2012 (com	npulsory), computer science	e mandatory courses, 1st se	emester
Classes and lectures: • Verteilte Systeme (lecture, 2 SWS) • Verteilte Systeme (exercise, 1 SWS)		Workload: • 40 Hours private • 30 Hours e-learn • 30 Hours in-class • 20 Hours exam p	studies ing sroom work oreparation
Contents of teaching: Introduction and motivation Protocols and layered models Message representations Realization of network services Communication mechanisms Addresses, names and directory serv Synchronisation Replication and consistency Fault tolerance Distributed transactions Security	rices		
 Qualification-goals/Competencies: The participants will accquire a deep handling, naming etc. They know the most important servi They are able to program simple dist They know the most important algo mutual exclsuion. They have a good feeling for when it They have a good feeling for what kit Grading through: written exam 	o understanding for proble ices in distributed systems tributed applications and s rithms in distributed syster t makes sense to use distril ind of solutions could best	ms to be solved in distribut such as name service, distr ystems themselves. ms, for instance for time syn buted instead of centralized be used for what kind of p	ted systems, such as synchronization, error ibuted file systems etc. nchronization, for leader election, or for d systems. roblems in distributed Internet applications.
Responsible for this module: • Prof. Dr. Stefan Fischer Teacher: • Institute for Theoretical Computer So • Institute of Telematics • Prof. Dr. Stefan Fischer • Prof. Dr. Rüdiger Reischuk Literature:	cience		
 A. Tanenbaum, M. van Steen: Distrib G. Coulouris, J. Dollimore, T. Kindber A. Tanenbaum, D.J. Wetherall: Comp R. Cahn: Wide Area Network Design M. G. Gouda: Elements of Network P N. Lynch: Distributed Algorithms - M 	uted Systems: Principles ar g, G. Blair: Distributed Syst buter Networks - Prentice H - Morgan Kaufmann 1998 rotocol Design - John Wile lorgan Kaufmann 1996 lorgan Kaufmann 1996	nd Paradigms - Prentice Ha ems - Concepts and Desigr all 2011 y 1998	ll 2006 n - Addison Wesley 2011

W. Reisig: Elements of Distributed Algorithms - Springer 1998



Language:

• offered only in German



	CS4160 - Real-Time	e Systems (Echtzeit)	
Duration:	Turnus of offer:		Credit points:
1 Semester	not available anymore		4
Course of study, specific field and term: • Master Computer Science 2012 (com	npulsory), computer science	e mandatory courses, 1st se	emester
Classes and lectures:		Workload:	
 Real-Time Systems (lecture, 2 SWS) Real-Time Systems (exercise, 1 SWS) 	Systems (lecture, 2 SWS)• 55 Hours private studiesSystems (exercise, 1 SWS)• 45 Hours in-classroom work• 20 Hours exam preparation		studies room work reparation
Contents of teaching:			
 Fundamentals of real-time processir Hardware platforms Process interface Real-time communications systems Real-time programming Real-time operating systems Real-time middleware Fault-tolerant real-time systems Application examples 	ng		
Qualification-goals/Competencies:			
 Students have developed an unders corresponding approaches for their They know the most important hard They have basic knowledge about fa They know typical application exam They are able to design and implem 	tanding of the fundamenta solution Iware and software compor ault tolerance techniques fo ples and are able to judge ent real-time systems	al problems of real-time pro nents of real-time systems or reliable and safe real-time which methods are applica	ocessing (e.g. hard, soft real-time) and the e systems for critical applications ble in which areas
Grading through: • written exam			
Responsible for this module:			
Prof. DrIng. Mladen Berekovic			
Teacher:			
 Institute of Computer Engineering 			
Prof. DrIng. Mladen Berekovic			
Literature: • : • : • : • :			
•:			
Language: • offered only in English			
Notes: Only CS4160-KP06 Real-Time Systems	is now offered for 6 credits		



CS4220 - Statistical Pattern Recognition (SME)			
Duration:	Turnus of offer:		Credit points:
1 Semester	not available anymore		4
Course of study, specific field and term: • Master MES 2011 (optional subject), • Master CLS 2010 (compulsory), math • Master MES 2011 (advanced curricul • Master Computer Science 2012 (com	mathematics, 1st semester nematics, 1st or 3rd semeste lum), imaging systems, sign npulsory), computer science	er aal and image processing, f e mandatory courses, 1st s	1st semester emester
Classes and lectures: Workload:			
 Pattern Recognition (lecture, 2 SWS) Pattern Recognition (exercise, 1 SWS) 	Ittern Recognition (lecture, 2 SWS)• 55 Hours private studiesIttern Recognition (exercise, 1 SWS)• 45 Hours in-classroom work• 20 Hours exam preparation		e studies sroom work preparation
Contents of teaching: Introduction to probability theory Principles of feature extraction and pattern recognition Bayes decision theory Discriminance functions Neyman-Pearson test Receiver Operating Characteristic Parametric and nonparametric density estimation kNN classifiers Linear classifiers Support vector machines and kernel trick Random Forest Neural Nets Feature reduction and feature transforms Validation of classifiers Selected application scenarios: acoustic scene classification for the selection of hearing-aid algorithms, acoustic event recognition, attention classifiers			
 Qualification-goals/Competencies: Students are able to describe the main of the students are able to explain the basic elitised in the b	ain elements of feature extr ements of statistical model	raction and pattern recogr ing.	nition.
They are able to use feature extracti	on, feature reduction and p	battern classification techn	iques in practice.
Grading through: • Written or oral exam as announced	by the examiner		
Responsible for this module: Prof. DrIng. Alfred Mertins Teacher: Institute for Signal Processing Prof. DrIng. Alfred Mertins 			
Literature: • R. O. Duda, P. E. Hart, D. G. Storck: Pa	attern Classification - New Y	/ork: Wiley	
Language: • offered only in German			
Notes:			



Prerequisites for attending the module: - None

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

Modul exam:

- CS4220-L1:Pattern Recognition, written exam, 90 Min, 100% of modul grade

New modul CS4220-KP04 Pattern Recognition



(S4230 - Human-Com	puter-Interaction (M	CI)
Duration:	Turnus of offer:		Credit points:
1 Semester	not available anymore		4
Course of study, specific field and term: • Master Computer Science 2012 (con	npulsory), computer science	mandatory courses, 1st se	emester
Classes and lectures:		Workload:	
Human-Computer-Interaction (lectu	re with exercises, 3 SWS)	 55 Hours private 45 Hours in-class 20 Hours exam p 	studies room work preparation
Contents of teaching:			
 Introduction and overview of the to Norms and legal foundations Human information processing and Models for human-computer system Input/Output devices and interactio User-centered development process Usability Engineering System paradigms and correspondin Evaluation and impact analyzes Innovative concepts and systems 	pic area processes of actions as and interactive media n technologies and special groups of user ng system examples	s	
Qualification-goals/Competencies:			
 The students know the principles ar They have basic knowledge about h They know the basic models of inter They have the ability to analyze and 	nd methods of the context-, uman information processin ractive systems und can app review interative systems b	task- and user-centered de ng and can introduce it int oly them for their analysis a pased on criteria.	evelopment of interactive systems. to the design process. and evaluation.
Grading through: • written exam			
Responsible for this module: • Prof. DrIng. Nicole Jochems Teacher: • Institute for Multimedia and Interact	ive Systems		
Prof. DrIng. Nicole Jochems			
Literature: M. Herczeg: Software-Ergonomie - M M. Herczeg: Interaktionsdesign - Mü D. Norman: The Design of Everyday B. Shneiderman, C. Plaisant: Designi J. Preece et al.: Human-Computer In Dix et al.: Human-Computer Interact Schlick et. al.: Arbeitswissenschaft - E.B. Goldstein: Wahrnehmungspsych A. Sears, J.A. Jacko: The Human-Com C. Stephanidis: User Interfaces for A	Aünchen: Oldenbourg 2009 nchen: Oldenbourg, 2006 Things - Cambridge, MA: Ba ng the User Interface - Read teraction - Addison Wesley, tion - Prentice Hall, 2003 Springer, 2010 hologie - Springer, 2002 hputer Interaction Handboo I - Laurence Erlbaum Associ	isic Books, 1988 ling, MA: Addison-Wesley, 1994 k - Lawrence Erlbaum Asso ates, 2001	2005 ociates, 2012
Language: • offered only in German			

Notes:



Studierende mit Anwendungsfach Medieninformatik können das Modul Mensch-Computer-Interaktion durch ein anderes Modul aus dem Wahlpflichtbereich Medieninformatik ersetzen.

Das Modul wird ab WS 2014/15 durch CS3010 abgelöst.



CS3205	-KP04, CS3205 - Com	puter Graphics (Com	pGrafik)
Duration:	Turnus of offer:		Credit points:
1 Semester	each summer semester		4
Course of study, specific field and term: Bachelor Computer Science 2019 (op Bachelor MES 2020 (optional subject Bachelor Media Informatics 2020 (co Bachelor Robotics and Autonomous Bachelor Medical Informatics 2019 (op Bachelor Computer Science 2016 (op Bachelor Robotics and Autonomous Bachelor Robotics and Autonomous Bachelor Robotics and Autonomous Bachelor IT-Security 2016 (optional se Bachelor Medical Informatics 2014 (op Bachelor Medical Informatics 2014 (co Bachelor Media Informatics 2014 (co Bachelor Computer Science 2014 (op Bachelor Medical Informatics 2011 (op Bachelor Computer Science 2012 (opt Bachelor CLS 2010 (optional subject), Bachelor Computer Science 2012 (opt Bachelor CLS 2010 (optional subject), for Bachelor CLS 2010 (optional subject), for Bachelor CLS 2010 (optional subject), for Bachelor Computer Science 2012 (opt Bachelor CLS 2010 (optional subject), for Bachelor Computer Science 2012 (optional subject), for Bachelor CLS 2010 (optional subject), for Bachelor Computer Science 2012 (optional subject), for Bachelor Computer Science 2012 (optional subject), for Bachelor Computer Science 2012 (optional subject), for Bachelor CLS 2010 (optional subject), for Bachelor CLS 2010 (optional subject), for Bachelor CLS 2010 (optiona	ptional subject), major subject), computer science / electr mpulsory), media informati Systems 2020 (optional sub optional subject), computer otional subject), major subject), computer science, optional subject), computer science / electr mpulsory), media informati optional subject), computer optional subject), computer onal subject), contral top mathematics, 2nd semester ompulsory), specialization fi	ect informatics, Arbitrary se rical engineering, 3rd seme bject), computer science, 5 science, 4th to 6th semest ect informatics, Arbitrary se bject), computer science, 5t Arbitrary semester science, 5th or 6th semest rical engineering, 4th or 6th ics, 6th semester ics of computer science, 5t science, 4th to 6th semest rriculum imaging systems, er ics of computer science, 5t seld media informatics, 5th	emester ister at the earliest ith or 6th semester emester th or 6th semester er h or 6th semester ier 2nd or 3rd semester h or 6th semester or 6th semester
Classes and lectures:		Workload:	
 Computer Graphics (lecture, 2 SWS) Computer Graphics (exercise, 1 SWS))	55 Hours private45 Hours in-class20 Hours exam p	studies room work reparation
Contents of teaching: Geometric transformations in 2D an Homogeneous coordinates Transformations between Cartesian Planar and perspective projections Polygonal models Illumination models and shading me Texture Mapping Culling and clipping Hidden line and surface removal Raster graphics algorithms Ray tracing Shadows, reflections and transparer Basics of graphics programming wit	d 3D coordinate systems ethods hOpenGL and GLSL		
Qualification-goals/Competencies: Students know the basic concepts, a They are able to implement and app They are able to explain the learned 	lgorithms and methods in o ly principle algorithms techniques and to assess th	computer graphics heir possibilities and limitat	tions
Grading through: • written exam			
Requires: Linear Algebra and Discrete Structur Linear Algebra and Discrete Structur Besponsible for this module:	es 2 (MA1500-KP08, MA150 es 1 (MA1000-KP08, MA100)0))0)	



Prof. Dr. rer. nat. habil. Heinz Handels
Teacher:
Institute of Medical Informatics
• Dr. rer. nat. Jan Ehrhardt
Literature:
• Foley et. al: Grundlagen der Computergrafik - Addison-Wesley, 1994
Language:
offered only in German
Notes:
Admission requirements for taking the module: - None (the competences of the modules listed under "requires" are needed for this module, but are not a formal prerequisite)
Admission requirements for participation in module examination(s): - Successful completion of exercise slips and programming projects as specified at the beginning of the semester
Module exam(s): - CS3205-L1: Computer Graphics, written exam, 90 min, 100 % of module grade



ME3520 - Projektpraktikum Bildgebung (PrBildgeb)			
Duration:	Turnus of offer:	Credit points:	
1 Semester	each semester	4 (Тур В)	
 Course of study, specific field and term: Master Computer Science 2012 (compulsory), advanced curriculum imaging systems, 2nd or 3rd semester 			
Classes and lectures: • Projektpraktikum Bildgebende Verfahren (project work, 2 SWS)		 Workload: 60 Hours group work 40 Hours private studies 20 Hours written report 	
Contents of teaching: • • • • • • • • • • • • •			
• • • • • •			
Grading through: • contributions to the discussion			
Responsible for this module: • Prof. Dr. rer. nat. Thorsten Buzug Teacher: • Institute of Medical Engineering • Prof. Dr. rer. nat. Thorsten Buzug • MitarbeiterInnen des Instituts Literature: • : Language: • offered only in German			



ME4020 - Imaging Systems 2 (BildgbSys2)				
Duration:	Turnus of offer:	Credit points:	Max. group size:	
1 Semester	each winter semester	4	99	
Course of study, specific field a • Master Computer Science • Master CLS 2010 (compu	and term: e 2012 (optional subject), advan Isory), computational life science	ced curriculum imaging systems, 2n e / imaging, 2nd semester	nd or 3rd semester	
Classes and lectures: Workload:				
 Imaging Systems 2 (lecture, 2 SWS) Imaging Systems 2 (exercise, 1 SWS) 		 55 Hours private str 45 Hours in-classroopered 20 Hours exam press 	 55 Hours private studies 45 Hours in-classroom work 20 Hours exam preparation 	
Contents of teaching:				
 Physical fundamentals of encodingprinciples of sp Construction of basic imates Concept of k-space Coherence pathways Hardware components of Possible sources of hazar Influence of measurement Causes of image artefact 	ⁱ magnetic resonance imaging: r atial encoding, relaxation) aging sequences, weighting of a clinical MR system rd for patients nt parameters on signal-to-noise s	nuclear magnetic resonance, relaxat e ratio	ion mechanisms, principles of position	
Qualification-goals/Competen The students can explain They can explain the idea They can recognise the complexity of the statement o	cies: the physical principles of NMR a behind important imaging seq auses of important image artefa and disadvantages of MRT, com urces of hazard for patients, expl	and MRI. Juences, using a pulse sequence dia acts. apared to other imaging techniques lain their causes and point out strate	gram. egies for avoiding these.	
Grading through: • Oral examination				
Responsible for this module: • Prof. Dr. rer. nat. Martin & Teacher: • Institute of Medical Engir • Prof. Dr. rer. nat. Martin &	Coch neering Koch			
Literature: • Liang, ZP., Lauterbur, P.	C.: Principles of Magnetic Resor	nance Imaging: A Signal Processing	Perspective - IEEE Press, New York 2000	
Language: • German and English skill:	s required			
Notes: In summer semester 2015 t	his course is replaced by ME441	3 Nuklear Imaging for MML student	ts.	



CS5910 - Processes for Fault Tolerance (Toleranz)			
Duration:	Turnus of offer:	Credit points:	
1 Semester	not available anymore	4	
Course of study, specific field an • Master Computer Science 2	d term: 2012 (optional subject), specializatio	n field IT security and safety, 2nd or 3rd semester	
Classes and lectures:Workload:• Processes for Fault Tolerance (lecture, 2 SWS)• 55 Ho• Processes for Fault Tolerance (exercise, 1 SWS)• 45 Ho• 20 Ho		Workload: • 55 Hours private studies • 45 Hours in-classroom work • 20 Hours exam preparation	
Contents of teaching: • • • • • •			
Qualification-goals/Competencie • • • •	es:		
Grading through: • Written or oral exam as anr	nounced by the examiner		
Responsible for this module: • Prof. DrIng. Mladen Berek Teacher: • Institute of Computer Engin • Prof. DrIng. Mladen Berek	ovic neering ovic		
Literature: • : • : • :			
Language: • offered only in German			



CS5930 - Security in Digital Economy (SiDigiWirt)			
Duration:	Turnus of offer:	Credit points:	
1 Semester	not available anymore	4	
Course of study, specific field and ter • Master Computer Science 2012	m: (optional subject), specializatic	on field IT security and safety, 2nd or 3rd semester	
Classes and lectures: • Security in Digital Economy (seminar-style lectures, 3 SWS)		 Workload: 55 Hours private studies 45 Hours in-classroom work 20 Hours exam preparation 	
Contents of teaching: • •			
Qualification-goals/Competencies: • • •			
Grading through: • Written or oral exam as announ	ced by the examiner		
Responsible for this module: • Prof. Dr. Rüdiger Reischuk Teacher: •			
Literature: • : • : • : • :			
Language: • German and English skills requi	red		



	CS5940 - Biometrical Systems (BiometSys)		
Duration:	Turnus of offer:		Credit points:
1 Semester	not available anymore		4
Course of study, specific field and tern • Master Computer Science 2012 (c	n: optional subject), specializatic	on field IT security and safet	y, 2nd or 3rd semester
Classes and lectures: • Biometrical Systems (lecture, 2 SWS) • Biometrical Systems (exercise, 1 SWS)		 Workload: 55 Hours private studies 45 Hours in-classroom work 20 Hours exam preparation 	
Contents of teaching: • • • • • • • • • • • • •	tents of teaching: • • • • • • • • • • • • • • • • • • •		
Grading through: • Written or oral exam as announce	ed by the examiner		
Responsible for this module: • Prof. DrIng. Erhardt Barth Teacher: • Institute for Neuro- and Bioinform • Prof. DrIng. Erhardt Barth	natics		
Literature: • : • : • :			
Language: • offered only in German			



CS5950 - Computer Forensics (Forensik)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	not available anymor	2	4	
Course of study, specific field • Master Computer Science	and term: ce 2012 (optional subject), specializa	ation field IT security and safety	2nd or 3rd semester	
Classes and lectures:Workload:• Computer Forensics (seminar-style lectures, 3 SWS)• 65 H• 45 H• 10 H		Workload: • 65 Hours private s • 45 Hours in-classr • 10 Hours exam pr	ours private studies lours in-classroom work lours exam preparation	
Contents of teaching: • • • • •				
Qualification-goals/Competencies:				
Grading through: Oral examination 				
Responsible for this module: Prof. Dr. Rüdiger Reischuk Teacher: Institute for Theoretical Computer Science 				
Literature: • : • : • :				
Language: • German and English skil	lls required			