

UNIVERSITÄT ZU LÜBECK

Module Guide for the Study Path

Bachelor Medical Informatics 2014

Version from 1. April 2025



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MZ2150 - Introduction to Medicine (EMed_)					
Duration:	Turnus of offer:		Credit points:		
2 Semester	not available anymore		12		
Course of study, specific field and term: • Bachelor MES 2011 (compulsory), m • Bachelor Medical Informatics 2011	edical engineering science compulsory), medical com	, 1st and 2nd semester outer science, 1st and 2nd s	semester		
Classes and lectures:Workload:• MZ2100 A: Anatomie (course, 2 SWS)• 180 Hours private studies• MZ2100 B: Pathologie (course, 2 SWS)• 120 Hours in-classroom work• MZ2100 D: Dialogie (course, 2 SWS)• 120 Hours in-classroom work		e studies ssroom work			
 MZ2100 D: Physiologie (course, 2 3 MZ2100 E: Zellbiologie und Genetil 	(course, 2 SWS) • 60 Hours exam preparation und Genetik (course, 2 SWS)				
Contents of teaching: • See individual module parts	Contents of teaching: • See individual module parts				
Grading through: • written exam					
Responsible for this module: • Prof. Dr. rer. nat. habil. Heinz Hande Teacher: • Institute for Biology • Institute of Neurobiology • Department of Pathology • Institute of Anatomy • Prof. Dr. med. Hartmut Gehring	ls				
Language: • offered only in German					



CS1000 - Programming (Prog)				
Duration: Turnus of offer:		Credit points:		
1 Semester each winter semester		8		
Course of study, specific field • Bachelor Medical Informa • Bachelor MES 2011 (com • Bachelor Computer Scier	and term: atics 2011 (compulsory: aptitude test), pulsory), foundations of computer scie nce 2012 (compulsory: aptitude test), o	, computer science, 1st sem ence, 3rd semester computer science, 1st seme	ester ster	
Classes and lectures:		Workload:		
 Programming (lecture, 4 SWS) Programming (exercise, 2 SWS) Programming (exercise, 2 SWS) State of the state o			e studies sroom work preparation	
Contents of teaching:				
 Definition: Algorithm Basic concepts of impera Basic data structures Abstract Data types 	tive and OO programming			
 Understanding the nature of algorithms and their definition Basic knowledge about different programming paradigms (imperative, declarative, object-oriented, etc.) Profound knowledge about imperative and object-oriented programming Ability to define abstract data types In-depth knowledge of the Java programming language Ability to design, to implement, and to test simple programs Expertise to solve bigger programming tasks efficiently and timely using the acquired competences Learn to come up with solutions that satisfy accepted quality standards while operating with constrained resources in terms of time, man-power, etc. Ability to introduce new informatic or mathematical methods to products to be developed or existing solutions Basic understanding of product development in enterprises 				
Grading through: • written exam				
Is requisite for: • Algorithms and Data Structures (CS1001-KP08, CS1001)				
Responsible for this module: Prof. Dr. Stefan Fischer Teacher: Institute of Telematics Prof. Dr. Stefan Fischer 				
Literature:				
 M. Broy: Informatik - eine grundlegende Einführung (Band 1 und 2) - Springer-Verlag 1998 G. Goos und W. Zimmermann: Vorlesungen über Informatik (Band 1 und 2) - Springer-Verlag, 2006 D. J. Barnes und M. Kölling: Objektorientierte Programmierung mit Java - Pearson Studium, 2003 T. Stark und G. Krüger: Handbuch der Java-Programmierung - 5. Auflage, Addison-Wesley, 2007 Robert Sedgewick und Kevin Wayne: Einführung in die Programmierung mit Java - Pearson Studium (ISBN-13: 978-3868940763) 				
Language:				

• offered only in German



CS1002-KP04, CS1002 - Introduction to Logics (Logik)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each summer semester		4	
Course of study, specific field and term: Bachelor MES 2014 (optional subject), computer science / electrical engineering, 3rd semester at the earliest Bachelor Media Informatics 2020 (compulsory), computer science, 2nd semester Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 2nd semester Bachelor Media Informatics 2019 (compulsory), foundations of computer science, 2nd semester Bachelor Medical Informatics 2019 (compulsory), computer science, 2nd semester Bachelor Medical Informatics 2019 (compulsory), computer science, 2nd semester Bachelor Medical Informatics 2019 (compulsory), computer science, 5th or 6th semester Bachelor Computer Science 2016 (compulsory), foundations of computer science, 3rd semester Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester Bachelor IT-Security 2016 (compulsory), computer science, 2nd semester Bachelor Medical Informatics 2014 (compulsory), computer science, 3rd semester Bachelor Medical Informatics 2014 (compulsory), computer science, 3rd semester Bachelor Computer Science 2014 (compulsory), computer science, 1st semester Bachelor Medical Informatics 2011 (compulsory), computer science, 1st semester Bachelor CLS 2010 (optional subject), computer science, 6th semester Bachelor CLS 2010 (optional subject), computer science, 5th semester 				
Classes and lectures:		Workload:		
 Introduction to Logic (lecture, 2 SWS Introduction to Logic (exercise, 1 SWS 	Introduction to Logic (lecture, 2 SWS) Introduction to Logic (exercise, 1 SWS) Introduction to Logic (exercise, 1 SWS) Vorkioad: • 65 Hours private studies and exercises • 45 Hours in-classroom work • 10 Hours exam preparation			
 Key concepts of syntax: alphabet, string, term, formula Key concepts of semantics: assignment, structure, model Key concepts of proof calculus: axioms, proofs Formlization and coding of problems Validating correctness and satisfiability of formalizations Syntax and semantics of propositional logic Syntax and semantics of predicate logig Proof caculi 				
 Qualification-goals/Competencies: Students are abel to explain the concepts of syntax and semantics for the examples of prepositional and predicate logic They are able to apply formal systems and proof systems They are able to transfer methods of mathematical logic to simple practical problems They are able to formalize discrete problems They are able to modify proof templates in order to create simple proofs 				
Grading through: written exam 				
Responsible for this module: • Prof. Dr. rer. nat. Till Tantau Teacher: • Institute for Theoretical Computer Science • Prof. Dr. rer. nat. Till Tantau • Prof. Dr. rer. nat. Till Tantau • Prof. Dr. res. nat. Till Tantau				
Literature: • Uwe Schöning: Logik für Informatiker - Spektrum Verlag, 1995				



• Kreuzer, Kühlig: Logik für Informatiker - Pearson Studium, 2006

Language:

offered only in German

Notes:

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- Successful completion of exercise slips as specified at the beginning of the semester.

Module Exam(s):

- CS1002-L1: Introduction to Logic, portfolio exam: a total of 70 points for written exercises down during the course of the semester, 30 points for the written exam at the end. The grade is calculated as follows: 50 to 54 points for a 4.0, then 55 to 59 points for a 3.7 and so on until the end 95 to 100 points for a 1.0.



CS1300-KP04, CS1300 - Introduction to Medical Informatics (EMI)			
Duration: Turnus of offer:		Credit points:	
1 Semester	each winter semester		4
Course of study, specific field and term: Bachelor IT-Security 2016 (optional subject), interdisciplinary, Arbitrary semester Bachelor Computer Science 2019 (optional subject), Introductory Module Computer Science, 1st semester Bachelor Robotics and Autonomous Systems 2020 (optional subject), medical computer science, 5th or 6th semester Bachelor Medical Informatics 2019 (compulsory: aptitude test), medical computer science, 1st semester Bachelor Computer Science 2016 (optional subject), Introductory Module Computer science, 1st semester Bachelor Computer Science 2016 (optional subject), Introductory Module Computer Science, 1st semester Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 1st semester Bachelor Medical Informatics 2014 (compulsory: aptitude test), medical computer science, 1st semester Bachelor Medical Informatics 2011 (compulsory: aptitude test), medical computer science, 1st semester Bachelor CLS 2010 (optional subject), computer science, 5th semester Bachelor MES 2011 (compulsory), foundations of computer science, 3rd semester Bachelor MES 2011 (compulsory), foundations of computer science, 3rd semester Bachelor MES 2011 (compulsory) secialization field medical informatics 1st semester			
Classes and lectures:		Workload:	
 Introduction to Medical Informatics (Introduction to Medical Informatics ((lecture, 2 SWS) (exercise, 1 SWS)	 55 Hours private 45 Hours in-classi 20 Hours exam private 	studies room work reparation
Contents of teaching: Basic concepts and methods of medical informatics Overview of the occupational field in medical informatics Introduction to the German healthcare system Introduction to medical documentation, including patient record Information systems in the healthcare sector Conceptual systems in medicine (classifications, terminologies) Medical informatics in clinical practice Principles of medical imaging: X-ray, ultrasound, CT, MRI Fundamentals of medical image computing and visualisation Medical sensor data analysis Medical decision support for diagnostics and therapy Health telematics Medical data security 			
 Qualification-goals/Competencies: Students know the fundamental terms and selected methods in the area of medical informatics. They know the main features of the German healthcare system. They are able to formulate the objectives and types of medical documentation including the electronic health record. They know the requirements for clinical information systems. They are able to formulate SQL queries and apply them to relational databases. They are able to explain the principles of medical imaging. They are able to explain the fundamentals of medical image processing and visualisation. They know selected application scenarios in the area of medical sensor data analysis. They know selected approaches for medical decision support. 			
Responsible for this module: • Prof. Dr. rer. nat. habil. Heinz Handels Teacher:	5		

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



- Prof. Dr.-Ing. Marcin Grzegorzek
- Prof. Dr. Mattias Heinrich

Literature:

- Th. Lehmann: Handbuch der Medizinischen Informatik 2nd Edition, München: Hanser 2004
- P. Haas: Medizinische Informationssysteme und Elektronische Krankenakten Berlin: Springer 2005
- F. Leiner, W. Gaus, R. Haux: Medizinische Dokumentation 4th Edition, Stuttgart: Schattauer 2003
- _____

Language:

offered only in German

Notes:

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

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

- Giving a short lecture as specified at the beginning of the semester

Module examinations:

- CS1300-L1: Introduction to Medical Informatics, written exam, 90min, 100% of module grade



MA1000-KP08, MA1000 - Linear Algebra and Discrete Structures 1 (LADS1)				
Duration:	Turnus of offer:	c	redit points:	
emester each winter semester		8		
Course of study, specific field and term: Minor in Teaching Mathematics, Ba Bachelor CLS 2023 (compulsory), n Bachelor Biophysics 2024 (compuls Bachelor Biophysics 2024 (compuls Bachelor Mels 2020 (compulsory: a Bachelor Media Informatics 2020 (c Bachelor Computer Science 2019 (Bachelor Robotics and Autonomou Bachelor Medical Informatics 2019 Minor in Teaching Mathematics, Ba Bachelor CLS 2016 (compulsory), n Bachelor CLS 2016 (compulsory), n Bachelor Robotics and Autonomou Bachelor Robotics and Autonomou Bachelor CLS 2016 (compulsory), n Bachelor Biophysics 2016 (compuls Bachelor Medical Informatics 2014 Bachelor Medical Informatics 2014 Bachelor Medical Informatics 2014 Bachelor Medical Informatics 2014 (compulsory); a Bachelor Medical Informatics 2014 (c Bachelor Computer Science 2014 (c Bachelor Computer Science 2014 (c Bachelor Medical Informatics 2011 Bachelor Computer Science 2012 (c Bachelor Medical Informatics 2011 Bachelor CLS 2010 (compulsory), n Bachelor CLS 2010 (compulsory), n	achelor of Arts 2023 (compu- nathematics, 1st semester sory), mathematics, 1st seme- sory), mathematics, 1st seme- sory), mathematics, 1st seme- ptitude test), mathematics, 2 compulsory), mathematics, 2 compulsory: aptitude test), r is Systems 2020 (compulsor (compulsory: aptitude test), achelor of Arts 2017 (compu- compulsory: aptitude test), r nathematics, 1st semester sory), mathematics, 1st seme- sory), mathematics, 1st seme- sory; aptitude test), mathematics, sory: aptitude test), mathematics, compulsory: aptitude test), ptitude test), mathematics, 2 compulsory: aptitude test), r (compulsory: aptitude test), r (compulsory: aptitude test), r (compulsory: aptitude test), r (compulsory: aptitude test), r nathematics, 1st semester nathematics, 1st semester	lsory), mathematics, 3rd semes ester ester Ist semester ard semester mathematics, 1st semester y: aptitude test), mathematics, mathematics, 1st semester lsory), mathematics, 3rd semes nathematics, 1st semester ester y: aptitude test), mathematics, atics, 1st semester mathematics, 1st semester lst semester nathematics, 1st semester mathematics, 1st semester mathematics, 1st semester mathematics, 1st semester mathematics, 1st semester mathematics, 1st semester mathematics, 1st semester	ster , 1st semester ster 1st semester	
Classes and lectures: • Linear Algebra and Discrete Struct • Linear Algebra and Discrete Struct	ures 1 (lecture, 4 SWS) ures 1 (exercise, 2 SWS)	Workload: • 125 Hours private st • 90 Hours in-classroo • 25 Hours exam prep	tudies and exercises om work paration	
 Contents of teaching: Fundamentals: logic, sets, mappings Relations, equivalence relations, orderings Proof by induction Groups: fundamentals, finite groups, permutations, matrices Rings, fields, congruencies Complex numbers: calculus, representation, roots of unity Vector spaces: bases, dimension, scalar product, norms 				
Qualification-goals/Competencies: Students understand the fundame They understand basic thought pr They can explain fundamental rela They can apply fundamental conce They have an understanding of ab Interdisciplinary qualifications: Students have basic competency i They can transfer fundamental the They can work on elementary mat They can present elementary solut Grading through:	ntal concepts of linear algeb ocesses and methods of pro tionships in linear algebra. epts and methods of proof t stract thought processes. n modelling. oretical concepts to similar hematics problems within a ions to their problems to a g	ora. of. o algebraic problems. applications. team. group.		
• written exam				



 Is requisite for: Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500)
Responsible for this module:
Prof. Dr. rer. nat. Jan Modersitzki
Teacher:
Institute of Mathematics and Image Computing
 Prof. Dr. rer. nat. Jan Modersitzki Prof. Dr. rer. nat. Jan Lellmann
Literature:
 G. Fischer: Lineare Algebra: Eine Einführung für Studienanfänger - Vieweg+Teubner G. Strang: Lineare Algebra - Springer K. Jänich: Lineare Algebra - Springer D. Lau: Algebra und diskrete Mathematik I + II - Springer G. Strang: Introduction to Linear Algebra - Cambridge Press K. Rosen: Discrete Mathematics and Its Applications - McGraw-Hill
Language: offered only in German
Notes:
Prerequisites for attending the module: - None
Prerequisites for the exam: - Successful completion of homework assignments during the semester - Successful completion of e-tests during the semester - Presentation of homework assignment
Module exam: - MA1000-L1: Linear Algebra and Discrete Structures 1, written exam, 90 min, 100 % of module grade



MZ2100 A - Module Part: Course Anatomy (Anatomie)				
Duration:	Turnus of offer:	Credit points:		
1 Semester	each winter semester	3		
Course of study, specific field and term:				
 Bachelor MES 2020 (Module part of a Bachelor Medical Informatics 2019 (I Bachelor MES 2014 (Module part of a Bachelor Medical Informatics 2014 (I Bachelor Medical Informatics 2011 (I Bachelor MES 2011 (Module part of a Bachelor Computer Science 2012 (M 	a compulsory module), medicine, 1st Module part of a compulsory module a compulsory module), medicine, 1st Module part of a compulsory module Module part of a compulsory module a compulsory module), medicine, 1st odule part of a compulsory module),	: semester e), medical computer science, 1st semester : semester e), medical computer science, 1st semester e), medical computer science, 1st semester e), medical computer science, 1st semester , specialization field medical informatics, 3rd semester		
Classes and lectures:	Workl	oad:		
Anatomy (lecture, 2 SWS)	Anatomy (lecture, 2 SWS) 45 Hours private studies 30 Hours in-classroom work 15 Hours exam preparation			
Contents of teaching:				
 Cytology Microscopic anatomy Anatomical regions of the human body using medical terms, to describe anatomical position relationships and their principle functions Musculoskeletal system Respiratory tract, digestive system and cardiovascular system Kidney and urinary system Spinal cord, brain and peripheral nerves Blood, immune system and endocrine system 				
 Students know the cell organelles and can describe their principle functions. Students are able to describe the basic function of the main body tissues: epithelial tissue, connective tissue, muscle tissue and nervou tissues. Students are able to name the anatomical regions of the human body using medical terms, to describe anatomical position relationships and their principle functions. Students are able to link main bones with respective body regions. Students are able to describe the structures and the principal functions of individual organ systems. Students have the competency to use the main medical terms. 				
Grading through:				
• written exam				
Responsible for this module: Prof. Dr. med. Jürgen Westermann 				
Eacher: Institute of Anatomy				
Prof. Dr. rer. nat. Kathrin Kalies				
Literature:				
 R. Eggers, O. Schmitt: Anatomie I + II - Skript zur Pflicht-Lehreinheit im Nebenfach Medizinische Informatik im Diplom-Studiengang Informatik. Hagen: Fern-Universität Hagen 2000 A. Faller, M. Schünke: Der Körper des Menschen. Einführung in Bau und Funktion - Thieme: Stuttgart 2012 				
Language: offered only in German				
Notes:				



Admission requirements for taking the module: - None

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

Module Exam(s):

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

(Is module part of MZ2151, MZ2160)



MZ2100 B - Module Part: Course Pathology (Patho)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	Semester each winter semester		3	
 Course of study, specific field and term: Bachelor MES 2020 (Module part of a compulsory module), medicine, 1st semester Bachelor Medical Informatics 2019 (Module part of a compulsory module), medical computer science, 3rd semester Bachelor Medical Informatics 2014 (Module part of a compulsory module), medical computer science, 3rd semester Bachelor MES 2014 (Module part of a compulsory module), medicine, 1st semester Bachelor MES 2014 (Module part of a compulsory module), medicine, 1st semester Bachelor Medical Informatics 2011 (Module part of a compulsory module), medical computer science, 1st semester Bachelor MES 2011 (Module part of a compulsory module), medicine, 1st semester Bachelor MES 2011 (Module part of a compulsory module), medicine, 1st semester Bachelor MES 2011 (Module part of a compulsory module), medicine, 1st semester Bachelor MES 2011 (Module part of a compulsory module), medicine, 1st semester 				
Classes and lectures:		Workload:		
Pathology (lecture, 2 SWS)		 45 Hours private 30 Hours in-class 15 Hours exam p 	studies room work reparation	
Contents of teaching:				
 To place the specialty of pathology in the context of medicine as a whole (looking to history and future) Specific methods of investigation in pathology To define terms like health, illness, death, aetiology, pathogenesis To define typical terms of medical statistics Description of morphological changes of cells and tissue with implications to diagnosis Basic mechanisms of pathogenesis, typical clinical progression of disease in different organ systems IT- applications in the area of pathology which support diagnostic work (Lab-devices, interfaces to connect lab and clinical systems as well as a private doctor s office, tele pathology) 				
 Qualification-goals/Competencies: Students are able to relate important historical dates and persons of pathology to diagnostic methods. They can describe methods like descriptive pathology, gross section, immunohistochemistry and molecular pathology. They are able to define terms like health, illness, death, aetiology and pathogenesis. Evaluating a case report, they will recognize the right definition. They are able to evaluate a given problem and determine appropriate descriptive terms like incidence or mortality. They are able to to analyse a small case report. They will recognize and explain different changes of cells and tissues in connection to a limited number of given diagnoses. They are able to name and describe different informatics application which are used in the pathology lab. They can specify the needs a pathologist will have to the technology. This will cover the benefit and the usability for the diagnostic work. 				
Grading through: • written exam				
Responsible for this module: • Prof. Dr. med. Sven Perner Teacher: • Department of Pathology • MitarbeiterInnen des Instituts • DiplIng. Harald Hatje				
 Literature: W. Böcker, H. Denk, P. U. Heitz, H. Moch: Pathologie - Urban & Fischer Verlag/Elsevier GmbH, 2012 M. Krams, S. O. Frahm, U. Kellner, C. Mawrin: Kurzlehrbuch Pathologie - Thieme 2013 R. Kramme: Medizintechnik, Verfahren - Systeme Informationsverarbeitung - Springer 2011 Language: 				



• offered only in German

Notes:

Admission requirements for taking the module: - None

Admission requirements for participation in module examination(s):

- None

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

(Is module part of MZ2152, MZ2160)

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





CS1001-KP08, CS1001 - Algorithms and Data Structures (AuD)				
Duration:	tion: Turnus of offer:		Credit points:	
1 Semester	each summer semester		8	
Course of study, specific field and term: • Bachelor CLS 2023 (compulsory), foundations of computer science, 2nd semester • Bachelor MES 2020 (optional subject), computer science, 2nd semester • Bachelor Media Informatics 2020 (compulsory), computer science, 2nd semester • Bachelor Computer Science 2019 (compulsory: aptitude test), foundations of computer science, 2nd semester • Bachelor Robotics and Autonomous Systems 2020 (compulsory), computer science, 2nd semester • Bachelor Medical Informatics 2019 (compulsory: aptitude test), foundations of computer science, 2nd semester • Bachelor Computer Science 2016 (compulsory), computer science, 2nd semester • Bachelor CLS 2016 (compulsory), foundations of computer science, 2nd semester • Bachelor CLS 2016 (compulsory), foundations of computer science, 2nd semester • Bachelor Robotics and Autonomous Systems 2016 (compulsory), computer science, 2nd semester • Bachelor Robotics and Autonomous Systems 2016 (compulsory), computer science, 2nd semester • Bachelor Robotics and Autonomous Systems 2016 (compulsory), computer science, 2nd semester • Bachelor IT-Security 2016 (compulsory: aptitude test), computer science, 2nd semester • Bachelor Medical Informatics 2014 (compulsory), computer science, 2nd semester • Bachelor Medical Informatics 2014 (compulsory), foundations of computer science, 2nd semester • Bachelor Medical Informatics 2014 (compulsory), foundations of computer science, 2nd semester • Bachelor Medical Informatics 2014 (compulsory), foundations of computer science, 2nd semester • Bachelor Medical Informatics 2014 (compulsory), computer science, 2nd semester • Bachelor Medical Informatics 2011 (compulsory), computer science, 2nd semester • Bachelor Medical Informatics 2011 (compulsory), computer science, 2nd semester • Bachelor MES 2011 (compulsory), foundations of computer science, 2nd semester • Bachelor MES 2011 (compulsory), foundations of computer science, 2nd semester • Bachelor Medical Informatics 2011 (compulsory), computer sci				
Classes and lectures:		Workload	· · · · · · · · · · · · · · · · · · ·	
 Algorithms and Data Structures (lect Algorithms and Data Structures (exe 	Algorithms and Data Structures (lecture, 4 SWS) Algorithms and Data Structures (exercise, 2 SWS) Algorithms and Data Structures (exercise, 2 SWS)			
 Contents of teaching: Sorting, algorithm analysis, heaps Distribution sort Priority queues Sets Sets Sets of strings Disjoint sets Associating objects Graphs Search graph for game playing Dynamic Programming principle, greedy algorithms Optimization problems, sequence alignment (longest common subsequence), knapsack problem, planning and layout problems, determining change coins, notion of completeness of algorithms String matching Hard problems Pruning and subgraph isomorphism Approximation 				
Qualification-goals/Competencies: • The students can explain the central ideas, define the relevant concepts and explain the functioning of algorithms with help of				
application scenarios for all the items listed in contents of teaching.				
Grading through: written exam				
Is requisite for: • Databases (CS2700-KP04, CS2700) • Lab Course Software Engineering (CS2301-KP06, CS2301)				





CS2700-KP04, CS2700 - Databases (DB)				
Duration:	Turnus of offer:	Credit points:		
1 Semester	each winter semester 4			
 Course of study, specific field and term: Bachelor Biophysics 2024 (optional subject), computer science, 6th semester Bachelor MES 2020 (optional subject), computer science / electrical engineering, 3rd semester at the earliest Bachelor Media Informatics 2020 (compulsory), computer science, 5th semester Bachelor Computer Science 2019 (compulsory), foundations of computer science, 3rd semester Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 5th or 6th semester Bachelor Medical Informatics 2019 (compulsory), foundations of computer science, 4th semester Bachelor Computer Science 2016 (compulsory), foundations of 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 Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester Bachelor IT-Security 2016 (compulsory), computer science, 6th semester Bachelor Biophysics 2016 (optional subject), computer science, 6th semester Bachelor MES 2011 (optional subject), computer science, 4th or 6th semester Bachelor MES 2014 (optional subject), computer science, 4th semester Bachelor Media Informatics 2014 (compulsory), foundations of computer science, 4th semester Bachelor Media Informatics 2014 (compulsory), foundations of computer science, 4th semester Bachelor Media Informatics 2014 (compulsory), computer science, 4th semester Bachelor Media Informatics 2014 (compulsory), foundations of computer science, 4th semester Bachelor Media Informatics 2014 (compulsory), foundations of computer science, 4th semester Bachelor Media Informatics 2014 (compulsory), foundations of computer science, 4th semester Bachelor Media				
Classes and lectures.	· · · · · · · · · · · · · · · · · · ·	Workload		
Databases (lecture, 2 SW	/S)	55 Hours private studies		
• Databases (exercise, 1 S	WS)	45 Hours in-classroom work		
		20 Hours exam preparation		
Contents of teaching:				
 Introduction, conceptua The relational data mod and relationships into th Database normalization, decomposition of relation Practical query language management* Integrity Storage structures and comanager, buffer manager Query processing* Index selection trees, query expartition-based join with Datalog* Syntax seman 	I view of database systems, conceptual el* Referential integrity, keys, foreign k ne relational data model* Update, inser closure w.r.t. FD set, canonical cover o on schemata, multi-value dependencies e: SQL* Selection, projection, join, aggre constraints latabase architecture* Characteristics o er, files and access methods, record allo king techniques, ISAM index, B+-tree in ecution plans, join operator: nested loo n hashing* Addition operators: groupin tics, treatment of peration (stratification	data modeling with the Entity-Relationship (ER) modeling language eys, functional dependencies (FDs)* Canonical mapping of entity types tions, and deletion anomalies* Relational algebra as a query language* of FD sets, normal forms, correct and dependency preserving s, inclusion dependencies egation, grouping, sorting, difference, relational algebra in SQL* Data of storage media, I/O complexity* DBMS architecture: disk space ocation strategies (row-wise, column-wise, mixed) dex, hash index* Sorting: Two-way merge sort, blockwise processing, ops join, blockwise nested loops join, index-based joins, sort-merge join, ig and duplicate elimination, selection, projection, pipeline principle un)* Evaluation strategies (naive, semi naive, magic set transformation)		

- Query optimization* Cost metrics, Estimating sizes of intermediate tables, selectivity* Join optimization, physical plan properties, interesting orders, query transformation* Index cuts, bitmap indexes
- Transactions and recovery* ACID, anomalies, serializability, locks, 2-phase commit protocol, concurrent access to index structures, isolation levels* Implementation of transaction w.r.t. ACID, shadow pages, write ahead log, snapshots

Qualification-goals/Competencies:

• For all subjects mentioned in the course contents under the indents students should name the central ideas, which can define relevant terms and explain the functioning of algorithms by means of application examples.

Grading through:

• written exam

Is requisite for:

• Nonstandard Databases and Data Mining (CS3130-KP08)



Nonstandard Database Systems (CS3202-KP04, CS3202)
Requires:
 Algorithms and Data Structures (CS1001-KP08, CS1001) Introduction to Programming (CS1000-KP08, CS1000SJ14-MML/MI, CS1000SJ14-MIW) Introduction to Programming (CS1000-KP10, CS1000SJ14)
Responsible for this module:
Prof. Dr. Sven Groppe
Teacher:
Institute of Information Systems
Prof. Dr. Sven Groppe
Literature:
A. Kemper, A, Eickler: Datenbanksysteme - Eine Einführung - Oldenbourg-Verlag
Language:
offered only in German
Notes:
Admission requirements for taking the module:
- None (the competences of the modules mentioned under "requires" are needed for this module, but are not a formal prerequisite).
Admission requirements for participation in module examination(s):
- Successful completion of exercise sheets as specified at the beginning of the semester.
Module Exam(s):
- CS2700-L1: Databases, written exam, 90min, 100% of the module grade.



MA1500-KP08, MA1500 - Linear Algebra and Discrete Structures 2 (LADS2)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each summer semester		8	
1 Semester each summer semester 8 Course of study, specific field and term: • Minor in Teaching Mathematics, Bachelor of Arts 2023 (compulsory), mathematics, 4th semester • Bachelor CLS 2023 (compulsory), mathematics, 2nd semester • Bachelor Sigophysics 2024 (compulsory), mathematics, 2nd semester • Bachelor Computer Science 2019 (compulsory: aptitude test), mathematics, 2nd semester • Bachelor Robotics and Autonomous Systems 2020 (compulsory), mathematics, 2nd semester • Bachelor Medical Informatics 2019 (compulsory), mathematics, 2nd semester • Bachelor Medical Informatics, Bachelor of Arts 2017 (compulsory), mathematics, 2nd semester • Bachelor Computer Science 2016 (compulsory), mathematics, 2nd semester • Bachelor Robotics and Autonomous Systems 2020 (compulsory), mathematics, 2nd semester • Bachelor Computer Science 2016 (compulsory), mathematics, 2nd semester • Bachelor Robotics and Autonomous Systems 2017 (compulsory), mathematics, 2nd semester • Bachelor Robotics and Autonomous Systems 2016 (compulsory), mathematics, 2nd semester • Bachelor Robotics and Autonomous Systems 2016 (compulsory), mathematics, 2nd semester • Bachelor Robotics and Autonomous Systems 2016 (compulsory), mathematics, 2nd semester • Bachelor Robotics and Autonomous Systems 2016 (compulsory), mathematics, 2nd semester • Bachelor Robotics and Autonomous Systems 2016 (compulsory), mathematics, 2nd semester • Bachelor Robotics and Autonomous Systems 2016 (compulsory), mathematics, 2nd semester • B				
Classes and lectures: • Linear Algebra and Discrete St • Linear Algebra and Discrete St	Classes and lectures: Workload: • Linear Algebra and Discrete Structures 2 (lecture, 4 SWS) • 125 Hours private studies and exercises • Linear Algebra and Discrete Structures 2 (exercise, 2 SWS) • 90 Hours in-classroom work • 25 Hours exam preparation			
 Contents of teaching: Systems of linear equations, matrices Determinants Linear mappings Orthogonality Eigenvalues Qualification-goals/Competencies: The students understand advanced concepts of linear algebra. They understand advanced thought processes and methods of proof. They can apply advanced concepts and methods of proof to algebraic problems. They can explain advanced theoretical concepts to similar applications. They have an advanced competency in modeling. They have an advanced competency in modeling. They can present the solution to complex problems to a group. 				
Grading through: • written exam				
Is requisite for: Image Registration (MA5030-KP05) Image Registration (MA5030-KP04, MA5030) Mathematical Methods of Image Processing (MA4500-KP05) Mathematical Methods in Image Processing (MA4500-KP04, MA4500) Optimization (Advanced Mathematics) (MA4031-KP08)				



 Module part: Optimization (MA4030 T) Optimization (MA4030-KP08, MA4030)
Requires:
Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000)
Responsible for this module:
Prof. Dr. rer. nat. Jan Modersitzki
Teacher:
Institute of Mathematics and Image Computing
Prof. Dr. rer. nat. Jan Modersitzki
Prof. Dr. rer. nat. Jan Lellmann
Literature:
 G. Fischer: Lineare Algebra: Eine Einführung für Studienanfänger - Vieweg+Teubner G. Strang: Lineare Algebra - Springer K. Jänich: Lineare Algebra - Springer D. Lau: Algebra und diskrete Mathematik I + II - Springer G. Strang: Introduction to Linear Algebra - Cambridge Press K. Rosen: Discrete Mathematics and Its Applications - McGraw-Hill
Language:
offered only in German
Notes:
Prerequisites for attending the module:
- None (The competencies of the modules listed under 'Requires' are needed for this module, but are not a formal prerequisite)
Prerequisites for the exam:
- Successful completion of homework assignments during the semester
- Successful completion of e-tests during the semester - Presentation of homework assignment
Module exam:
-MA1500-L1: Linear Algebra and Discrete Structures 2, written exam, 90 min, 100 % of module grade



ME1550 - Einführung in die Medizintechnik (EinfMedtec)				
Duration: Turnus of offer: Credit points:				
1 Semester each summer semester		r 4		
Course of study, specific field and Bachelor Medical Informatics Bachelor MES 2011 (computer Bachelor Computer Science Bachelor Computer Science	t erm: s 2011 (compulsory), medical co sory), medical engineering scien 2012 (compulsory), specializatio 2012 (compulsory), specializatio	mputer science, 2nd semester ice, 2nd semester in field robotics and automation, 2nd semester in field medical informatics, 2nd semester		
Classes and lectures: • Einführung in die Medizintechnik (lecture, 2 SWS) • Einführung in die Medizintechnik (exercise, 1 SWS)		 Workload: 55 Hours private studies 45 Hours in-classroom work 20 Hours exam preparation 		
Contents of teaching: Abriss zur historischen Entwicklung von Medizin und Medizintechnik Grundlagen der Anatomie und Physiologie Verfahren der Funktionsdiagnostik Bildgebende Systeme Therapiesysteme Monitoring Medizinische Informationsverarbeitung Wichtige gesetzliche Vorschriften 				
Qualification-goals/Competencies Grundlagen der medizinisch Verständnis komplexer Zusa Kompetenz im Umgang mit	s: Ien Messtechnik Immenhänge bei der Messtechn Messunsicherheiten	ik physiologischer Parameter		
Grading through: • Written or oral exam as announced by the examiner				
Responsible for this module: • Prof. Dr. rer. nat. Thorsten Buzug Teacher: • Institute of Medical Engineering • MitarbeiterInnen des Instituts • Prof. Dr. rer. nat. Thorsten Buzug Literature: • : • : • : • : • :				
• offered only in German				



MZ2100 D - Module Part: Course Physiology (Physio)				
Duration: Turnus of offer: Credit points:			Credit points:	
1 Semester	semester each summer semester			
Course of study, specific field and term: Bachelor MES 2020 (Module part of Bachelor Medical Informatics 2019 (Bachelor Medical Informatics 2014 (Bachelor MES 2014 (Module part of Bachelor MES 2011 (Module part of Bachelor Medical Informatics 2011 (a compulsory module), meo Module part of a compulsor Module part of a compulsor a compulsory module), meo a compulsory module), meo Module part of a compulsor	dicine, 2nd semester ry module), medical compu ry module), medical compu dicine, 2nd semester dicine, 2nd semester ry module), medical compu	iter science, 2nd semester iter science, 2nd semester iter science, 2nd semester	
Classes and lectures:		Workload:		
Physiology (lecture, 2 SWS)		 45 Hours private 30 Hours in-class 15 Hours exam p 	studies room work reparation	
Contents of teaching:				
 Blood & immune system Heart & circulation Respiration Nutrition, intestinal tract, liver Energy and heat metabolism Water and electrolyte balance, kidney function Endocrine system Central and autonomous nervous system Muscle physiology Sensory physiology 				
 Qualification-goals/Competencies: Students are able to explain the concepts of interaction of different cells and tissues of the human body. Students are able to formalize and interpret the principles of cellular communication in selected organ systems. Students are able to transfer principles of cellular communication and tissue homeostasis to new systems. Students are able to define physiological problems and transfer them to experimental approaches. Students are able to interpret assay patterns in physiological sciences and apply them to new systems. 				
Grading through:				
• written exam				
Responsible for this module: • Prof. Dr. rer. nat. Henrik Oster Teacher: • Institute of Neurobiology • Prof. Dr. rer. nat. Henrik Oster				
 Literature: C. & A. Hick: Kurzlehrbuch Physiologie - München: Urban & Fischer (Elsevier) L.S. Costanzo: BRS Physiology - Philadelphia: Lippincott Williams & Wilki 				
Language: offered only in German				
Notes:				



Admission requirements for taking the module: - None

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

Module Exam(s):

- MZ2160-L2: Physiology for technical courses, written exam, 60min, 100% of the submodule grade.

(Is module part of MZ2151, MZ2160)

(Share of Institute of Neurobiology in V is 100%)



MZ2100 E - Module Part: Course Cell Biology and Genetics (Zellbio)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each summer semester		3	
Course of study, specific field and term: • Bachelor Medical Informatics 2014 • Bachelor MES 2011 (Module part o • Bachelor Medical Informatics 2011	(Module part of a compulso f a compulsory module), me (Module part of a compulso	ry module), medical compu dical engineering science, 2 ry module), medical compu	iter science, 4th semester 2nd semester iter science, 2nd semester	
Classes and lectures:Workload:• Cell Biology and Genetics (lecture, 2 SWS)• 45 Hours private• 30 Hours in-class• 30 Hours in-class• 15 Hours example		studies room work reparation		
 Contents of teaching: Structure and functions of biological macromolecules Internal organization and functioning of cells Molecular genetics and gene regulation, epigenetics Flow of genetic information; genotype vs. phenotype Cell cycle Classical genetics Human genetics and inheritable diseases Ecological aspects of medicine (Interactions of humans, microbes, & environment) 				
Qualification-goals/Competencies: Ability, to understand and reproduce the basics in the areas listed under content of teaching and to use them in the further studies 				
Grading through: • written exam				
Is requisite for: • Molecular Genetics (LS3100)				
Responsible for this module: • Prof. Dr. rer. nat. Enno Hartmann Teacher: • Institute for Biology • Prof. Dr. rer nat. Rainer Duden • PD Dr. rer. nat. Bärbel Kunze • Dr. rer. nat. Nicole Sommer				
Literature: • Markl (Hrsg.): Biologie - Klett 2010 (ISBN: 978-3-12-150010-9)				
Language: • offered only in German				



CS2300 - Software Engineering I (SWTech)					
Duration:	Turnus of offer:	Credit points:	Max. group size:		
2 Semester	each winter semester	8	12		
Course of study, specific field • Bachelor Medical Inform • Bachelor CLS 2010 (optic • Bachelor Computer Scie	Course of study, specific field and term: Bachelor Medical Informatics 2011 (compulsory), computer science, 3rd and 4th semester Bachelor CLS 2010 (optional suject), computer science, 5th and 6th semester Bachelor Computer Science 2012 (compulsory), foundations of computer science, 3rd and 4th semester 				
Classes and lectures:Workload:• Software Engineering I (lecture, 2 SWS)• 60 Hours private studies and exercises• Software Engineering I (exercise, 1 SWS)• 45 Hours in-classroom work• Software Engineering I (practical course, 3 SWS)• 45 Hours in-classroom work• 40 Hours group work• 35 Hours work on project• 15 Hours exam preparation			tudies and exercises bom work bom work ork project eparation		
Contents of teaching:					
 overview on major field. Software development, Basic concepts of software System analysis and req Software design and softing Implementation Testing and integration Installation, acceptance, 	s of software engineering software process models are sysems uirements engineering tware architectures maintainance				
Qualification-goals/Competer • Understanding software • Kowledge of major software • Ability to model software • Ability to systematically • Knowing the basic conc • Usage of UML and CASE • Qualification to work in	ncies: e design as an engineering proce ware process models and descri re systemson different levels of design software systems whose epts of object-oriented modellin tools a team,to present artefacts, to c	ess ption formalisms for software artefa abtraction e implemention meets the requirem ng and design comply tostandards and to observe	cts ents time limits		
Grading through:Written or oral exam as announced by the examiner					
Requires:					
 Algorithms and Data Structures (CS1001-KP08, CS1001) Programming (CS1000) 					
Responsible for this module: • Prof. Dr. Martin Leucker					
I eacher: Institute of Software Technology and Programming Languages					
Prof. Dr. Martin Leucker					
Literature: • H. Balzert: Lehrbuch der • B. Brügge, A. H. Dutoit: (• I. Sommerville: Software • B. Oestereich: Analyse u • D. Bjorner: Software Eng	Software-Technik: Software-En Dbjektorientierte Softwaretechr Engineering - Addison-Wesley nd Design mit der UML 2.1 - Ob Jineering 1-3 - Springer 2006	twicklung - Spektrum Akademische nik mit UML, Entwurfsmustern und J 2006 njektorientierte Softwareentwicklung	r Verlag 2001 ava - Pearson Studium 2004 g - Oldenbourg 2006		



Language:

• offered only in German



CS1400-KP04, CS1400 - Introduction to Bioinformatics (EinBioinfo)				
Duration:	n: Turnus of offer:		Credit points:	
1 Semester	each winter semester		4	
Course of study, specific field and term: Bachelor IT-Security 2016 (optional subject), interdisciplinary, Arbitrary semester Bachelor Nutritional Medicine 2024 (compulsory), mathematics / computer science, 5th semester Bachelor Molecular Life Science 2024 (compulsory), mathematics / computer science, 5th semester Bachelor MES 2020 (optional subject), computer science / electrical engineering, 3rd semester at the earliest Bachelor Computer Science 2019 (compulsory), Canonical Specialization Bioinformatics and Systems Biology, 1st semester Bachelor Computer Science 2019 (optional subject), Introductory Module Computer Science, 1st semester Bachelor MLS 2018 (compulsory), jife sciences, 5th semester Bachelor MLS 2014 (optional subject), computer science / electrical engineering, 3rd semester at the earliest Bachelor Computer Science 2016 (optional subject), Introductory Module Computer Science, 1st semester Bachelor Computer Science 2016 (optional subject), Introductory Module Computer Science, 1st semester Bachelor Computer Science 2016 (compulsory), Canonical Specialization Bioinformatics, 1st semester Bachelor Computer Science 2016 (compulsory), Canonical Specialization Bioinformatics, 1st semester Bachelor MLS 2016 (compulsory), Ife sciences, Sth semester Bachelor Medical Informatics 2014 (compulsory), medical computer science, 3rd semester Bachelor Medical Informatics 2011 (compulsory), medical computer science, 3rd semester Bachelor MLS 2009 (compulsory), life sciences, Sth semester Bachelor MLS 2009 (compulsory), pecialization field bioinformatics, 1st semester Bachelor MLS 2010 (compulsory), specialization field bioinformatics, 1st semester Bachelor MLS 2011 (optional subject), medical engineering science, 3rd or Sth semester Bachelor MES 2011 (optional subject), medical engineering science, 3rd or Sth semester Bachelor CLS 2010 (compulsory), specialization field bioinformatics, 1st semester Bachelor CLS 2010 (compulsory), specialization field bioinformatics, 1st semester Bachelor S				
Classes and lectures:	re 2 SWS)	• 55 Hours private	studies	
 Introduction to Bioinformatics (lecture, 2 SWS) Introduction to Bioinformatics (exercise, 1 SWS) 45 Hours in-classroom work 20 Hours exam preparation 		sroom work preparation		
 Contents of teaching: Life, Evolution & the Genome Sequence assembly - Industrial reading of genetic information DNA sequence models & hidden markov models Viterbi-Algoritm Sequence alignment & dynamic programming Unsupervised data analysis (k-means, PCA, ICA) DNA microarrays & GeneChip technologies 				
 Qualification-goals/Competencies: Students are able to explain the basi They are able to explain how a soluti They are able to create a Markov cha They are able to give examples on ho They are able to implement the intro They are able to use unsupervised le They are able to explain basic Microard 	c concepts of coding, trans ion of the shortest commor in or a Hidden Markov Moo ow to solve a problem usin oduced algorithms (in Matla arning methods and they a array-and DNA-Chip-Techno	cription and translation of n superstring problem can del (HMM) for a given moc g dynamic programming. ab) are able to interpret the res blogies.	Finformation in living beings. be estimated with a simple greedy algorithm. felling problem. sults.	
Grading through: • portfolio exam				
Responsible for this module: • Prof. Dr. rer. nat. Amir Madany Mamle Teacher: • Institute for Neuro- and Bioinformatic • Prof. Dr. rer. nat. Amir Madany Mamle	ouk cs ouk			



Literature:

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

• M. S. Waterman: Introduction to Computational Biology - Chapman and Hall, 1995

Language:

offered only in German

Notes:

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

Prerequisites for attending the module:

- None

Computer Science students get a B certificate.



CS2000-KP08, CS2000 - Theoretical Computer Science (TI)			
Duration:	Puration: Turnus of offer:		Credit points:
1 Semester	each winter semester		8
1 Semester each winter semester 8 Course of study, specific field and term: Bachelor Media Informatics 2020 (compulsory), computer science, 3rd semester Bachelor Computer Science 2019 (compulsory), foundations of computer science, 3rd semester Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 5th or 6th semester Bachelor Medical Informatics 2019 (compulsory), foundations of computer science, 3rd semester Bachelor Computer Science 2016 (compulsory), foundations of computer science, 3rd semester Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 3rd 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), computer science, 3rd semester Bachelor MES 2011 (optional subject), computer science, 5th semester Bachelor Medical Informatics 2014 (compulsory), computer science, 3rd semester Bachelor Computer Science 2014 (compulsory), foundations of computer science, 3rd semester Bachelor Computer Science 2014 (compulsory), computer science, 3rd semester			
Bachelor Computer Science 2012 (cc	compulsory), computer scie	computer science, 3rd sem	ester
Classes and lectures:		Workload	
Theoretical Computer Science (lecture) Theoretical Computer Science (exercised)	Workload:e (lecture, 4 SWS)• 135 Hours private studies and exercisese (exercise, 2 SWS)• 90 Hours in-classroom work• 15 Hours exam preparation		e studies and exercises room work reparation
 Contents of teaching: Formalization of problems using languages formal grammars regular languages, finite automata context free language, push down automata sequential computational models: Turing machines, register machines sequential complexity classes simulations, reductions, completeness satisfiability problem, NP-completeness (In-)decidability and enumerability halting problem and Church-Turing thesis Qualification-goals/Competencies: Students are able to present the theoretical foundation of syntax and operational semantics of programming languages They are able to transform formalizations using theorems of theoretical computer science. They can classify problems according to their computational complexity They are able to model algorithmic problems and solve them using appropriate tools They can judge what computer science can and cannot achieve in principle 			
Grading through: written exam and course achievements			
Is requisite for: • Parallel Computing (CS3051-KP04, CS3051)			
 Requires: Algorithms and Data Structures (CS1001-KP08, CS1001) Introduction to Programming (CS1000-KP08, CS1000SJ14-MML/MI, CS1000SJ14-MIW) Introduction to Programming (CS1000-KP10, CS1000SJ14) 			
Responsible for this module: • Prof. Dr. Rüdiger Reischuk Teacher:			



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

Literature:

• J. Hopcroft, R. Motwani, J. Ullman: Introduction to Automata Theory, Languages and Computation - Addison Wesley, 2001

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Language:

offered only in German

Notes:

Admission requirements for taking the module:

- None (the competences of the modules indicated under



MA2000-KP08, MA2000 - Analysis 1 (Ana1KP08)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each winter semester 8			
Course of study, specific fiele Bachelor CLS 2023 (co Minor in Teaching Ma Bachelor Biophysics 2 Bachelor Media Inforr Bachelor Media Inforr Bachelor Computer Sc Bachelor Robotics and Bachelor Medical Infor Minor in Teaching Ma Bachelor CLS 2016 (co Bachelor CLS 2016 (co Bachelor Robotics and Bachelor IT-Security 2 Bachelor Biophysics 2 Bachelor Medical Inforr Bachelor Medical Inforr Bachelor Medical Inforr Bachelor Medical Inforr Bachelor Medical Inforr Bachelor Medical Inforr Bachelor Medical Infor Bachelor Medical Infor	eld and term: pompulsory), mathematics, 1st semester ithematics, Bachelor of Arts 2023 (compuls 2024 (compulsory: aptitude test), mathematics, 1st matics 2020 (compulsory: aptitude test), m cience 2019 (compulsory), mathematics, 1st d Autonomous Systems 2020 (compulsory) prmatics 2019 (compulsory), mathematics, 1st d Autonomous Systems 2017 (compulsory) prmatics, Bachelor of Arts 2017 (compulsory) prmatics, Bachelor of Arts 2017 (compulsory), mathematics, 1st pompulsory), mathematics, 1st semester d Autonomous Systems 2016 (compulsory) 2016 (compulsory), mathematics, 1st semester 2016 (compulsory), mathematics, 1st semester 2016 (compulsory), mathematics, 1st prmatics 2014 (compulsory), mathematics, 1st compulsory: aptitude test), mathematics, 1st compulsory: aptitude test), mathematics, 1st compulsory: aptitude test), mathematics, 1st compulsory: aptitude test), mathematics, 1st compulsory, mathematics, 1st semester compulsory),	sory), mathematics, 5th se atics, 1st semester st semester hathematics, 1st semester st semester y: aptitude test), mathemat 1st semester sory), mathematics, 5th se st semester r: aptitude test), mathemat ster atics, 1st semester 1st semester st semester st semester st semester st semester st semester at semester at semester st semester at semester	emester atics, 1st semester emester tics, 1st semester	
Bachelor Computer Se	cience 2012 (compulsory), mathematics, 3	rd semester		
 Analysis 1 (lecture, 4) Analysis 1 (exercise, 2) 	SWS) 2 SWS)	 Workload: 125 Hours private studies 90 Hours in-classroom work 25 Hours exam preparation 		
Contents of teaching:		·		
 Sequences and series Functions and contin Differentiability, Taylo Metric and normalize Multivariate different 	; uity or series d spaces, basic topological concepts ial calculus			
Qualification-goals/Compe	tencies:			
 Students understand Students understand technically motivated Students can explain Students can apply th Students have an und Interdisciplinary quali Students have a basic Students can transfer Students can work as 	the basic terms of analysis, especially the the basic thoughts and proof techniques a problems. basic relationships in real analysis. ne basic concepts and proof techniques of derstanding for abstract structures. ifications: c competence in modeling. r theoretical concepts to similar applications a group on elementary mathematical pro	concept of convergence. and are able to use them ^f differential calculus. ns. oblems.	for the analytical treatment of scientifially or	
Grading through:				
written exam				
Is requisite for: • Analysis 2 (MA2500-K • Analysis 2 (MA2500-K	(P09) (P08)			



 Analysis 2 (MA2500-KP05, MA2500-MLS) Analysis 2 (MA2500-KP04, MA2500)
Responsible for this module:
Prof. Dr. rer. nat. Jürgen Prestin
Teacher:
Institute for Mathematics
Prof. Dr. rer. nat. Jürgen Prestin
PD Dr. rer. nat. Jörn Schnieder
Literature:
• K. Fritzsche: Grundkurs Analysis 1 + 2
H. Heuser: Lehrbuch der Analysis 1 + 2
K. Burg, H. Haf, F. Wille, A. Meister: Höhere Mathematik für Ingenieure
• R. Lasser, F. Hormaler: Analysis 1 + 2
Language:
offered only in German
Notes:
Admission requirements for taking the module:
- None
Admission requirements for participation in module examination(s):
- Successful completion of homework assignments during the semester
- Successful completion of e-tests
Modul exam:
- MA2000-L1: Analysis 1, written exam, 90 min, 100 % of module grade





MZ4010-KP04, MZ4010 - Clinical Epidemiology (KlinEpi)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each winter semester		4	
Course of study, specific field and te Master CLS 2023 (compulsory), Bachelor Medical Informatics 20 Master CLS 2016 (compulsory), Bachelor Medical Informatics 20 Bachelor Medical Informatics 20 Master CLS 2010 (compulsory), Master Computer Science 2012	rm: MML with specialization in Gen D19 (optional subject), medical of MML with specialization in Gen D14 (compulsory), medical comp D11 (compulsory), medical comp computational life science / bio (compulsory), specialization fie	etic Statistics, 3rd semeste computer science, 4th to 6 etic Statistics, 3rd semeste outer science, 5th semeste outer science, 3rd semeste statistics, 1st semester Id medical informatics, 3rd	er 5th semester er 9r 9r d semester	
Classes and lectures:		Workload:		
 Clinical Epidemiology (lecture, 2 SWS) Clinical Epidemiology (exercise, 1 SWS) 		 55 Hours private studies and exercises 45 Hours in-classroom work 20 Hours exam preparation 		
Contents of teaching:				
 Introduction to epidemiology Diagnosis Frequencies Registers and data sources Geographical epidemiology Study designs (RCT, cohort study, case control study, cross sectional study) Effect measures Causality Chance, bias and confounding Control of errors Outbreak investigation 				
 Qualification-goals/Competencies: Students are able to explain technical terms such as disease register, incidence, prevalence, mortality, lethality, standardization. They are able to explain and interpret epidemiological measures. They are able to assess which study design is appropriate for a certain research question. They are able to identify possible sources of error, bias and confounding and how they affect the study results. They are able to assess causal inferences in the context of different study types. They are able to critically appraise data, results, and epidemiological research methods as well as scientific literature in the context of medicine and epidemiology. 				
Grading through:				
• written exam				
Responsible for this module: • Prof. Dr. med. Alexander Katalinic Teacher: • Institute for Social Medicine and Epidemiology • Prof. Dr. med. Alexander Katalinic • MitarbeiterInnen des Instituts				
Literature:				
 L. Gordis: Epidemiology - Oxford: Elsevier; 5th edition 2013 R. H. Fletcher: Clinical Epidemiology. The Essentials Lippincott Williams & Wilki; 5th rev. edition 2012 : 				
Language:				



• offered only in German

Notes:

Prerequisites for attending the module: - None

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

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



CS1200-MI - Fundamentals of Computer Engineering (TGI)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each summer semester		8	
Course of study, specific field and term: • Bachelor Medical Informatics 2011 (compulsory), computer science, 4th semester Classes and lectures: Workload: • Fundamentals of Computer Engineering (lecture, 4 SWS) • 120 Hours private studies • Fundamentals of Computer Engineering (exercise, 2 SWS) • 90 Hours in-classroom work • 30 Hours exam preparation				
Contents of teaching: Boolean algebra Switching functions Minimization Combinational logic Sequential logic Register-transfer languag Data processing units Control units Microprogramming Basic processor architecte Microcontrollers Assembler programming I/O-interfaces Interrupts Semiconductor compone Circuit families Integraded circuits Programmable logic CAD-tools Memory technologies	les ures			
 Qualification-goals/Competencies: Students know the most important methods for the formal description of digital circuits like Boolean algebra or register-transfer languages They are well acquainted with the basic design methods for digital circuits on gate and register-transfer level They have knowledge about basic processor architectures and their programming in machine language They know the basic technologies for the realization of digital circuits (bipolar, MOS, CMOS) 				
Grading through: • Viva Voce or test				
 Is requisite for: Laboratory Fundamentals of Computer Engineering (CS1201) 				
Responsible for this module: • Prof. DrIng. Mladen Bere Teacher: • Institute of Computer Eng • Prof. DrIng. Mladen Bere	kovic gineering kovic			
 Literature: T.L. Floyd: Digital Fundamentals - A Systems Approach - Pearson 2012 M. M. Mano, C. R. Kime: Logic and Computer Design Fundamentals - Pearson Prentice Hall 2007 				


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

Language:

• offered only in German



CS2150 - Computer Networks (CN)			
Duration:	Turnus of offer:		Credit points:
1 Semester	each summer semester		4
Course of study, specific field and term: • Bachelor Medical Informatics 2011 (compulsory), computer science, 4th semester • Bachelor MES 2011 (optional subject), Applied computer science, 6th semester • Bachelor Computer Science 2012 (compulsory), foundations of computer science, 4th semester			
Classes and lectures: • Computer Networks (lecture, 2 SWS) • Computer Networks (exercise, 1 SWS)	Classes and lectures:Workload:• Computer Networks (lecture, 2 SWS)• 65 Hours priva• Computer Networks (exercise, 1 SWS)• 45 Hours in-cla• 10 Hours example		studies sroom work preparation
Contents of teaching: Computer Networks and the Internet Application Layer Transport Layer Network Layer Link and Physical Layer 			
 Qualification-goals/Competencies: At the end of the course, students know the most important concepts ofcomputer networks Students know the importance of the different layers of the OSI andInternet protocol suite along with the most important protocols andservices of each layer The students are able decide which network technologies to use to meetthe requirements of any given application scenario The students know how the Internet works and are able to program smallapplications Students can apply the most important methods and algorithms from thefield of networks 			
Grading through: written exam 			
Responsible for this module: Prof. Dr. Stefan Fischer Teacher: Institute of Telematics Prof. Dr. Stefan Fischer 			
Literature: • James Kurose, Keith Ross: Computer Networking - Der Top-Down-Ansatz - Pearson Studium, 2012 • Andrew S. Tanenbaum: Computernetzwerke - Pearson Studium, 2012			
Language: • offered only in German			



	CS3300-MI - Informatics in	n Health Care - eHealth	(eHealth)
Duration:	Turnus of offer:		Credit points:
1 Semester	each summer semest	er	4
Course of study, specific field • Bachelor Medical Inform	l and term: natics 2011 (compulsory), medical ce	omputer science, 4th semeste	r
Classes and lectures: • Medical information sc • Medical information sc	on science (lecture, 2 SWS) on science (exercise, 1 SWS) • 20 Hours exam pro- • 20 Hours exam		e studies sroom work preparation
Contents of teaching: Health Care System: organization, legislation and funding Distributed patient care and patient records Medical Documentation and Communication Coding of diagnoses and procedures Hospital Information Systems DRG-based compensation system and accounting of cases Telematics in medicine: electronic health insurance card 			
Qualification-goals/Compete Insight into the method Ability to independent Ability to assess the up	ncies: Is and procedures of subfields of me processing of selected tasks with sp coming IT challenges in view of the	edical informatics pecialized tools current political and economi	cal developments in the health care system
Grading through:Written or oral exam as announced by the examiner			
Responsible for this module: • Prof. Dr. rer. nat. habil. I Teacher: • Institute of Medical Info • Prof. Dr. rer. nat. habil.	Heinz Handels ormatics losef Ingenerf		
 Literature: T. Lehmann: Handbuch der Medizinischen Informatik - München: Hanser 2004 P. Haas: Medizinische Informationssysteme und Elektronische Krankenakten - Berlin: Springer 2005 J. Ingenerf, R. Linder, S. J. Pöppl: Informatik im Gesundheitswesen - Skript zur Pflicht-Lehreinheit im Nebenfach Medizinische Informatik im Diplom-Studiengang Informatik - Hagen: Fern-Universität Hagen 2002 			
Language: • offered only in German			



MA1600-KP04, MA1600, MA1600-MML - Biostatistics 1 (BioStat1)			
Duration:	Turnus of offer:		Credit points:
1 Semester	each summer semester		4
Course of study, specific field and term: Bachelor CLS 2023 (compulsory), mathematics, 2nd semester Bachelor Biophysics 2024 (compulsory), Elective Computer Science, 4th semester Bachelor Nutritional Medicine 2024 (compulsory), nathematics / natural sciences, 3td semester Bachelor Nutritional Medicine 2024 (compulsory), canonical Specialization Bioinformatics and Systems Biology, 6th semester Bachelor Computer Science 2019 (optional subject), Extended optional subjects, Arbitrary semester Bachelor MES 2018 (compulsory), Canonical Specialization Bioinformatics and Systems Biology, 6th semester Bachelor Medical Informatics 2019 (compulsory), medical computer science, 6th semester Bachelor Mutritional Medicine 2018 (compulsory), mathematics / computer science, 6th semester Bachelor CLS 2016 (compulsory), mathematics, 2nd semester Bachelor Computer Science 2016 (optional subject), advanced curriculum, Arbitrary semester Bachelor Gomputer Science 2016 (compulsory), Canonical Specialization Bioinformatics, 4th semester Bachelor RULS 2016 (compulsory), Canonical Specialization Bioinformatics, 4th semester Bachelor Sufficience 2016 (compulsory), Canonical Specialization Bioinformatics, 4th semester Bachelor RULS 2016 (compulsory), Iffe sciences, 6th semester Bachelor RULS 2016 (compulsory), Elective Computer Science, 4th semester Bachelor RULS 2016 (compulsory), mathematics / computer science, 6th semester Bachelor Nutritional Medicine 2014 (compulsory), medical computer science, 4th semester Bachelor Medical Informatics 2014 (compulsory), medical computer science, 4th semester Master Computer Science 2012 (optional subject), specialization field bioinformatics, 2nd semester Master MES 2011 (advanced curriculum), biophysics and biomedical optics, 2nd semester Master Computer Science 2012 (compulsory), specialization field bioinformatics, 2nd or 3r			ester earliest semester d Systems Biology, 6th semester mester ter th semester mester nester nester or 3rd semester ster o semester
Classes and lectures: • Biostatistics 1 (lecture 2 SWS)		Workload: • 66 Hours private	studios
 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 II Linear simple regression Analysis of variance (one-way-classification) Clinical trials Multiple Testing: Bonferroni, Bonferroni-Holm, Bonferroni-Holm-Shaffer, Wiens, hierarchical Testing 			
Qualification-goals/Competencies:			
 With regard to the roles of GSP of th statistical methods:The students are They are able to calculate quantiles They are able to explain terms of dia 	e University of Lübeck and of able to calculate descriptive and surfaces of the normal di agnostic testing, such as sensi	f the DFG-guidelines the statistics. stribution. tivity or specificity.	student were able to work with the following

• 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



MA2500-KP04, MA2500 - Analysis 2 (Ana2KP04)			
Duration:	Turnus of offer:		Credit points:
1 Semester	each summer semester		4
Course of study, specific field and t Bachelor Computer Science 2 Bachelor Robotics and Autore Bachelor Medical Informatics Bachelor IT-Security 2016 (opt Bachelor Computer Science 2 Bachelor Robotics and Autore Bachelor Medical Informatics Bachelor Computer Science 2 Bachelor Medical Informatics Bachelor Medical Informatics Bachelor MES 2011 (compulse Bachelor Computer Science 2	rerm: 019 (optional subject), Extended omous Systems 2020 (compulso 2019 (compulsory), mathematics, cional subject), mathematics, Arb 016 (compulsory), mathematics, omous Systems 2016 (compulsor 2014 (compulsory), mathematics, 2014 (compulsory), mathematics, 2011 (compulsory), mathematics ory), mathematics, 2nd semester 012 (compulsory), mathematics,	optional subjects, Arbitrary ry), mathematics, 2nd seme , 2nd semester itrary semester 2nd semester y), mathematics, 2nd semes , 2nd semester 2nd semester , 4th semester 4th semester	v semester ester ster
Classes and lectures:		Workload:	
 Analysis 2 (lecture, 2 SWS) Analysis 2 (exercise, 1 SWS) 		 60 Hours private 45 Hours in-class 15 Hours example 	e studies sroom work oreparation
 Integral calculus for functions fundamental theorem of calculation of the sequences and series of functions. Fourier series (trigonometric provide the series of the sequences and series of function. Fourier series (trigonometric provide the sequences of the sequences of the sequences. Students understand the advance of the sequences. Students understand the advance of the sequences. Students can explain advance of the sequences. Students can transfer advance of the sequences. Students can work as a group of the sequences. Grading through: written exam 	of one real variable (indefinite in ulus) cions polynomials, convergence) anced terms of analysis, such as a anced thoughts and proof techn ed relationships in analysis. s: ed theoretical concepts to simila o on complex mathematical prob	ntegrals, antiderivatives, sul even convergence. iques. r applications. lems.	bstitution, partial fractions, definite integrals,
Requires: • Analysis 1 (MA2000-KP09) • Analysis 1 (MA2000-KP08, MA	2000)		
Responsible for this module: • Prof. Dr. rer. nat. Jürgen Presti Teacher: • Institute for Mathematics • Prof. Dr. rer. nat. Jürgen Presti	n n		
Literature: • K. Fritzsche: Grundkurs Analys • H. Heuser: Lehrbuch der Anal • K. Burg, H. Haf, F. Wille, A. Me • R. Lasser, F. Hofmaier: Analysi Language:	sis 1 + 2 ysis 1 + 2 ister: Höhere Mathematik für Ing s 1 + 2	enieure	



• offered only in German

Notes:

Admission requirements for taking the module:

- None (the competences of the modules mentioned under "requires" are needed for this module, but are not a formal prerequisite).

Admission requirements for the examination:

- Successful completion of exercises during the semester as specified at the beginning of the semester.
- Successful completion of e-tests as specified at the beginning of the semester.

Module Exam(s):

- MA2500-L1: Analysis 2, written exam, 90min, 100% of the module grade





CS1100 - Operating systems (BetriebSys)			
Duration:	Turnus of offer:		Credit points:
1 Semester	on request		4
Course of study, specific field and term: • Bachelor Medical Informatics 2011 (c • Bachelor Computer Science 2012 (cc	optional subject), compute ompulsory), foundations of	er science, 4th to 6th semest computer science, 1st seme	er ester
 Classes and lectures: Operating Systems (lecture, 2 SWS) Operating Systems (exercise, 1 SWS) 		Workload: • 65 Hours private • 45 Hours in-classi • 10 Hours exam p	studies room work reparation
Contents of teaching: • Tasks and Structure • Historical Overview of Computer and Operating Systems • Coding of Symbols and Numbers • Foundations of Operating Systems • Processes, Inter-Process Communication and Process Management • Storage Management • Input / Output • Files and File Systems • Examples (UNIX, Windows, mobile OS)			
 Qualification-goals/Competencies: Students know about the main concepts of operating systems. Students are able to judge, which OS concepts can be appropriately applied to novel computing architectures. Students are able to apply the most important strategies and algorithms for operating systems. 			puting architectures. tems.
Grading through: written exam 			
Responsible for this module: • Prof. Dr. Stefan Fischer Teacher: • Institute of Telematics • Prof. Dr. Stefan Fischer • Prof. DrIng. Andreas Schrader			
Literature: • Andrew S. Tanenbaum: Moderne Be	triebssysteme - 3., aktualis	ierte Auflage, Pearson, April	2009
Language:• offered only in German			



Γ

CS	1201 - Laboratory Fundamentals	s of Computer Engineering (PrakTGI)
Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4 (Тур В)
Course of study, specific fie • Bachelor Medical Info	Id and term: rmatics 2011 (optional subject), compute	r science, 4th to 6th semester
Classes and lectures: • Fundamentals of Computer Engineering (practical course, 3 SWS)		 Workload: 65 Hours private studies 45 Hours in-classroom work 10 Hours exam preparation
Contents of teaching: •		
Qualification-goals/Competent • They are able to design FPGAs etc.) • They are able to prog	t encies: In simple digital circuits making use of CA ram microcontrollers for simple application	AD-tools, to implement and test them in different technologies (TTL, ons in assembly language
Grading through: • continuous, successfu	l participation in practical course	
Requires: • Fundamentals of Com	nputer Engineering (CS1200-MI)	
Responsible for this module • Prof. DrIng. Mladen f Teacher: • Institute of Computer • Prof. DrIng. Mladen f	e: Berekovic Engineering Berekovic	
Literature: • :		
Language: • offered only in Germa	n	



CS2101-KP04, CS2101 - Embedded Systems (ES)			
Duration:	Turnus of offer:		Credit points:
1 Semester	each summer semester		4
 Course of study, specific field and term: Bachelor Robotics and Autonomous Systems 2020 (optional subject), Additionally recognized elective module, Arbitrary semester Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester Bachelor Computer Science 2019 (optional subject), Canonical Specialization SSE, 6th semester Bachelor MES 2020 (optional subject), computer science / electrical engineering, 3rd semester at the earliest Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester Bachelor Computer Science 2016 (optional subject), Canonical Specialization SSE, 6th semester Bachelor Robotics and Autonomous Systems 2016 (optional Subject), computer science, 5th or 6th semester Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester Bachelor Robotics 2016 (optional subject), computer science, 6th or 6th semester Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester Bachelor Robotics 2016 (optional subject), computer science, 5th or 6th semester Bachelor IT-Security 2016 (optional subject), computer science, 5th or 6th semester Bachelor Medical Informatics 2014 (optional subject), computer science, 5th or 6th semester Bachelor Medical Informatics 2014 (optional subject), central topics of computer science, 6th semester Bachelor Computer Science 2014 (optional subject), central topics of computer science, 6th semester Bachelor Computer Science 2014 (compulsory), specialization field robotics and automation, 4th semester Bachelor Medical Informatics 2011 (optional subject), computer science, 6th semester Bachelor Medical Informatics 2011 (optional subject), computer science,			
Classes and lectures:		Workload	
 Embedded Systems (lecture, 2 SWS) Embedded Systems (exercise, 1 SWS) 	• Embedded Systems (lecture, 2 SWS) • 60 Hours private studies and exercises • Embedded Systems (exercise, 1 SWS) • 45 Hours in-classroom work • 15 Hours exam preparation		studies and exercises room work reparation
 Target architectures (microcontrollers, FPGAs etc.) Conceptional models Peripheral buses Scheduling algorithms and real-time operating systems Specification languages Transformation from specification to implementation Development tools Programming of embedded systems using C 			
 Qualification-goals/Competencies: Students are able to explain the differences between desktop systems and embedded systems. They are able to select an appropriate hardware architecture for an embedded system. They are able to select appropriate communication protocols for interfacing peripheral components. They are able to control peripheral components with a microcontroller. They are able to model embedded systems conceptually and to specify them formally. They are well acquainted with the model-based design and tool-based implementation and of simple embedded systems. They can independently implement the specifications of the embedded systems with real-time capability and deterministic time behavior 			
Grading through: • written exam Requires: • Introduction to Programming (CS1000-KP10, CS1000SJ14) • Fundamentals of Computer Engineering 1 (CS1200-KP06, CS1200SJ14)			
Responsible for this module: Prof. DrIng. Mladen Berekovic 			



Teacher:

• Institute of Computer Engineering

• Prof. Dr.-Ing. Mladen Berekovic

Literature:

- P. Marwedel: Eingebettete Systeme Berlin: Springer 2007
- W. Wolf: Computers as Components Principles of Embedded Computing System Design San Francisco: Morgan Kaufmann 2012
- D.D. Gajski, F. Vahid, S. Narayan, J. Gong: Specification and Design of Embedded Systems Englewood Cliffs: Prentice Hall 1994
- U. Brinkschulte, T. Ungerer: Mikrocontroller und Mikroprozessoren Berlin: Springer 2010
- H. Woern, U. Brinkschulte: Echtzeitsysteme Berlin: Springer 2005

Language:

• offered only in German

Notes:

Admission requirements for taking the module:

- None (the competencies of the modules listed under



CS2102 - Computer Architecture (RA)			
Duration:	Turnus of offer:		Credit points:
1 Semester	each summer semester		4
Course of study, specific field and term: • Bachelor Medical Informatics 2011 (optional subject), compute	er science, 4th to 6th semest	er
Classes and lectures:Workload:• Computer Architecture (lecture, 2 SWS)• 60 Hours private studies• Computer Architecture (exercise, 1 SWS)• 45 Hours in-classroom work• 15 Hours exam preparation		studies room work reparation	
Contents of teaching: • Basic terms and concepts • Processor architectures • Computer components • Multiprocessors, multicomputer • Vector processors, array processors • Performance evaluation • Parallel computer architectures			
 Qualification-goals/Competencies: elucidate the microarchitecture of modern processors and the corresponding methods for performance enhancement (caches, pipelining, VLIW, multi/manycore, virtualization etc.), explain important computer components (busses, storage hierachies, I/O-units), discuss and compare the most important parallel computer architectures (multiprocessors, multicomputers, vector computers, array computers etc.), judge and make use of methods for performance evaluation (benchmarks, monitoring, queuing models etc.). 			
Grading through: • Viva Voce or test			
Requires: • Fundamentals of Computer Engine	ering (CS1200-MI)		
Responsible for this module: • Prof. DrIng. Mladen Berekovic Teacher: • Institute of Computer Engineering • Prof. DrIng. Mladen Berekovic			
 Literature: J.L. Hennessy, D.A. Patterson: Computer Architecture - A Quantitative Approach - Morgan Kaufmann 2011 D.A. Patterson, J.L. Hennessy: Rechnerorganisation und -entwurf - Die Hardware/Software-Schnittstelle - Pearson Studim, 2012 W. Stallings: Computer Organization and Architecture - Pearson Education 2012 A.S. Tanenbaum, T. Austin: Structured Computer Organization - Pearson Education 2012 		Kaufmann 2011 Schnittstelle - Pearson Studim, 2012	
Language: • offered only in German			





CS2200-KP04, CS2200 - Software Ergonomics (SoftErgo)			
Duration:	on: Turnus of offer: Credit points:		Credit points:
1 Semester	each summer semester		4
Course of study, specific field and term Bachelor IT-Security 2016 (optional Bachelor Media Informatics 2020 (Bachelor Psychology 2016 (option Bachelor Psychology 2013 (option Bachelor Media Informatics 2014 (Bachelor Medical Informatics 2011 Bachelor Computer Science 2012 (: I subject), specific, Arbitrary s compulsory), media informat al subject), computer science al subject), computer science compulsory), media informat (optional subject), software (compulsory), foundations of	semester ics, 2nd semester , Arbitrary semester , Arbitrary semester ics, 2nd semester engineering, 4th to 6th ser computer science, 2nd ser	mester mester
Classes and lectures:		Workload:	
 Software Ergonomics (lecture, 2 S) Software Ergonomics (exercise, 1 S) 	 Software Ergonomics (lecture, 2 SWS) Software Ergonomics (exercise, 1 SWS) Software Ergonomics (exercise, 1 SWS) 45 Hours in-classroom work 20 Hours exam preparation 		e studies sroom work oreparation
Contents of teaching:			
 Motivation and introduction Models of HCI Modes of input & input devices Modes of output & output devicdes Time behavior of interactive systems Graphical control elements Usability and usability processes Digital work 			
Qualification-goals/Competencies:			
 The students know the basic theo They are able to transfer this know They can describe work systems a 	ries, models and criteria for u vledge into development pro s well as applications in educ	ser- and application-cente cesses and to evaluate inte ation and entertainment in	ered interactive multimedia systems. eractive systems systematically. n a user- and task-centered way.
Grading through:			
 portfolio exam - the concrete examination elements and their weights will be published in the course 			n the course
Responsible for this module:			
Prof. Dr. rer. nat. Hans-Christian Je	tter		
Teacher:			
 Institute for Multimedia and Intera 	Institute for Multimedia and Interactive Systems		
 Prof. Dr. rer. nat. Hans-Christian Jetter MitarbeiterInnen des Instituts 			
Literature:			
 M. Herczeg: Software-Ergonomie - 4. Auflage, München: Oldenbourg-Verlag, 2018 Jetter, H.: D 3 Mensch-Computer-Interaktion, Usability und User Experience - In R. Kuhlen, D. Lewandowski, W. Semar & C. Womser-Hacker (Ed.), Grundlagen der Informationswissenschaft (pp. 525-534). Berlin, Boston: De Gruyter Saur. 			
Language:• offered only in German			
Notes:			



Prerequisites for attending the module: - None

Prerequisites for the exam:

- Successful completion of homework assignments as stated at the beginning of the course

Exams:

- CS2200-L1 Software-Ergonomie, oral exam, 50% of the grade

- CS2200-L1 Software-Ergonomie, portfolio exam, 50% of the grade during the semester



CS2500-KP04, CS2500 - Robotics (Robotik)			
Duration:	Turnus of offer:		Credit points:
1 Semester	each winter semester		4
 Course of study, specific field and term: Bachelor Robotics and Autonomous Systems 2020 (compulsory), Robotics and Autonomous Systems, 3rd semester Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester Bachelor MES 2020 (optional subject), computer science / electrical engineering, 3rd semester at the earliest Bachelor Media Informatics 2020 (optional subject), modical computer science, 4th to 6th semester Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester Bachelor Medical Informatics 2019 (optional subject), major subject informatics, Arbitrary semester Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 3rd semester Bachelor IT-Security 2016 (optional subject), computer science, Arbitrary semester Bachelor MES 2014 (optional subject), computer science / electrical engineering, 5th semester Bachelor Medical Informatics 2014 (optional subject), medical computer science, 5th or 6th semester Bachelor Computer Science 2014 (optional subject), central topics of computer science, 5th semester Bachelor Computer Science 2014 (compulsory), specialization field robotics and automation, 3rd semester Bachelor Computer Science 2012 (optional subject), central topics of computer science, 5th semester Bachelor Computer Science 2012 (optional subject), central topics of computer science, 5th semester Bachelor Computer Science 2012 (optional subject), central topics of computer science, 5th semester Bachelor Computer Science 2012 (optional subject), central topics of computer science, 5th semester Bachelor Computer Science 2012 (optional subject), central topics of computer science, 5th semester Bachelor Medical Informatics 201			
Classes and lectures:		Workload:	
 Robotics (lecture, 2 SWS) Robotics Exercise (exercise, 2 SWS) 		 60 Hours in-classr 60 Hours private 	room work studies
 Contents of teaching: Description of serial robotic systems: This part includes the basic components like different types of joints, sensors and actors. Exemplarily, the differing kinematic types are introduced. Also, the mathematical backgrounds are presented, necessary for the description of robots. The direct and inverse kinematics for typical 6-jointed industrial robots is explained. Parallel robot systems: This part deals with the transfer of the results and mathematical models of part 1 onto robotic systems with parallel kinematics. Movement: Robot movements along trajectories/geometric paths are analyzed. Different techniques of path planning are presented as well as methods to determine the configuration space and to perform velocity planning and kinematics. Robot Control: Techniques of control theory and examples of programming techniques in robotics are introduced. Sensor and systems calibration as a typical application of robotics is explained in detail. 			
 Qualification-goals/Competencies: The students are able to solve application-oriented exercises with mathematical background self-dependent, timely and in team work. They have gained basic understanding for the kinematic features of serial and simple parallel robots (includes knowledge of transformations, Euler-/Tail-Bryan-Angles, quaternions, etc.) They made first experiences with the programming of simple robotic applications. They comprehend the complexity and necessity for different path and dynamic planning techniques. The students gained an insight into simple methods for system and sensor calibration. 			
Grading through: • portfolio exam			
Is requisite for: • Lab Course Robotics and Automation	Is requisite for: • Lab Course Robotics and Automation (CS3501-KP04, CS3501)		
Requires: • Analysis 1 (MA2000-KP08, MA2000) • Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000)			
Responsible for this module:			



• Prof. Dr. rer. nat. Floris Ernst

Teacher:

• Institute for Robotics and Cognitive Systems

• Prof. Dr. rer. nat. Floris Ernst

Literature:

- M. Spong et al.: Robot Modeling and Control Wiley & Sons, 2005
- H.-J. Siegert, S. Bocionek:: Robotik: Programmierung intelligenter Roboter Springer Verlag, 1996
- J.-P. Merlet: Parallel Robots Springer Verlag, 2006
- M. Haun: Handbuch Robotik Springer Verlag, 2007
- S. Niku: Introduction to Robotics: Analysis, Control, Applications Wiley & Sons, 2010

Language:

offered only in German

Notes:

Admission requirements for taking the module

- None (the competences of the modules mentioned under Requires are needed for this module, but are not a formal prerequisite)

Admission requirements for participation in module examination(s):

- None

Module Exam(s):

- CS2500-L1: Robotics, portfolio examination consisting, 100% of the module grade

Note: The portfolio examination consists of: 70 points in the form of a written examination at the end of the semester, 15 points in the form of semester-accompanying programming tasks (group and individual performance), 15 points in the form of semester-accompanying intermediate tests (individual performance)



	CS2600 - Interaction	n Design (InterakDes)	
Duration:	Turnus of offer:	Credit points:	
1 Semester	each winter semester	4	
Course of study, specific field and term: • Bachelor Computer Science 2012 (o • Bachelor Medical Informatics 2011 (• Bachelor Computer Science 2012 (c	ptional subject), central top optional subject), compute ompulsory), specialization f	pics of computer science, 5th semester er science, 4th to 6th semester field media informatics, 3rd semester	
Classes and lectures: Workload: • Interaction Design (lecture with exercises, 3 SWS) • 55 Hours private studies • 45 Hours in-classroom work • 20 Hours exam preparation		 Workload: 55 Hours private studies 45 Hours in-classroom work 20 Hours exam preparation 	
Contents of teaching:			
 Introduction and overview Basic models of multimedia and interactive systems System paradigms Design patterns Modalities of interaction Information output and output devices Information input and input devices Help systems History systems Activity management systems Individualization of interactive systems Summary 			
 Qualification-goals/Competencies: The students are able to use system Besides the psychological and component communication design. They are capable of categorizing experience. 	natically and theoretically for outer science basics they bu isting systems and develop	ounded methods for the design of user interfaces of interactive systems. uild up knowledge about methods from the areas of graphic design and o concepts for improving them.	
Grading through: • written exam			
Is requisite for: Lab class media and interaction design (CS3600) Media Production and Media Programming (CS2601) Usability Engineering (CS3201-KP04, CS3201) 			
Requires: • Software Ergonomics (CS2200-KP04, CS2200)			
Responsible for this module: • Dr. Thomas Winkler Teacher: • Institute for Multimedia and Interactive Systems • Dr. Thomas Winkler			
 M. Herczeg: Interaktionsdesign - Oldenbourg-Verlag, 2006 B. Shneiderman, C. Plaisant: Designing the User Interface - Addison-Wesley, 2009 			



Language:

• offered only in German





CS3200 - Software Engineering II (SWEng)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	not available anymore		4	
 Course of study, specific field and term: Bachelor Medical Informatics 2011 (optional subject), software engineering, 4th to 6th semester Bachelor CLS 2010 (optional subject), computer science, 5th or 6th semester Bachelor MES 2011 (compulsory), foundations of computer science, 5th semester Bachelor Computer Science 2012 (compulsory), foundations of computer science, 5th semester 				
Classes and lectures:Workload:• Software Engineering II (lecture, 2 SWS)• 60 Hours private studies and exercises• Software Engineering II (exercise, 1 SWS)• 45 Hours in-classroom work• 15 Hours exam preparation			studies and exercises room work reparation	
Contents of teaching: Introduction to software engineering Software management Software quality assurance Software evolution Software reuse Re-engineering and phase-out Software productivity, expense, and estimation Legal aspects				
 Qualification-goals/Competencies: Knowing the basic procedures of software engineering Quality awareness Knowing activities and factors of software management Ability to organize software projects and to evaluate software engineering processes Understanding software evolution 				
Grading through:Written or oral exam as announced by the examiner				
Responsible for this module: • Prof. Dr. Martin Leucker Teacher: • Institute of Software Technology and Programming Languages • PD Dr. Gerhard Buntrock				
 Literature: H. Balzert: Lehrbuch der Software-Technik: Software-Management, Software-Qualitätssicherung - Akademischer Verlag 1998 A. Behforooz, F. J. Hudson: Software Engineering Fundamentals - Oxford University Press 1996 C. Ghezzi, M. Jazayeri, D. Mandrioli: Fundamentals of Software Engineering - Prentice Hall 2002 B. Hughes, M. Cotterell: Software Project Management - McGraw-Hill 1999 I. Sommerville: Software Engineering - Addison Wesley 2006 				



CS3201-KP04, CS3201 - Usability Engineering (UsabUXEng)				
Duration:	Turnus of offer:	Credit points:		
1 Semester	each winter semester	4		
Course of study, specific fiel Bachelor Media Inform Bachelor Computer Sc Bachelor Computer Sc Bachelor Robotics and Bachelor Computer Sc Bachelor Computer Sc Bachelor Robotics and Bachelor Robotics and Bachelor IT-Security 20 Bachelor Media Inform Bachelor Computer Sc Bachelor Computer Sc Bachelor Computer Sc Bachelor Computer Sc Bachelor Computer Sc	d and term: natics 2020 (compulsory), media informa ience 2019 (optional subject), major sub ience 2019 (compulsory), Canonical Spe Autonomous Systems 2020 (optional s ience 2016 (optional subject), major sub ience 2016 (compulsory), Canonical Spe Autonomous Systems 2016 (optional su 2016 (optional subject), computer science natics 2014 (compulsory), media informa ience 2014 (optional subject), central to matics 2011 (optional subject), software ience 2012 (compulsory), specialization ience 2012 (optional subject), central to	itics, 5th semester oject informatics, Arbitrary semester cialization SSE, 5th semester ubject), computer science, 5th or 6th semester oject informatics, Arbitrary semester cialization SSE, 5th semester ubject), computer science, 5th or 6th semester e, Arbitrary semester itics, 5th semester pics of computer science, 5th semester e engineering, 4th to 6th semester field media informatics, 6th semester pics of computer science, 6th semester		
Classes and lectures:		Workload:		
Usability Engineering (lecture, 2 SWS) Usability-Engineering (exercise, 1 SWS) 20 Hours exam preparation		 55 Hours private studies 45 Hours in-classroom work 20 Hours exam preparation 		
 Usability and UX target Cost-benefit analysis Design and conceptio Organizational and co User analyses Task analyses Modeling and design of Evaluation of interactions Statistical methods of Interdisciplinary teams Embedding usability and 	it criteria for interactive systems n methods for user experience ntext analysis of interactive systems ve systems: planning, implementation a usability and UX evaluation s and social processes ind UX in business processes	nd evaluation		
Qualification-goals/Compet Students can explain a You can adapt and ap They can apply usabili their results. They can justify the in human-centered deve The exercise trains tea Grading through: written exam	encies: and implement the basic human-centere ply the basic processes for development ty and user experience engineering met fluence of formal and informal requirem lopment processes. m skills, structured work, time managen	ed development processes for multimedia interactive systems. It projects to suit the problem. It hods in a targeted manner and evaluate, reflect on and communicate Itents as well as complex social structures and behaviors on Inent and presentation skills.		
Requires:Software Ergonomics ((CS2200-KP04, CS2200)			
Responsible for this module • Prof. Dr. phil. André Ca Teacher:	:: ilero Valdez			



 Institute for Multimedia and Interactive Systems 	

• Prof. Dr. phil. André Calero Valdez

Literature:

- Deborah J. Mayhew: The Usability Engineering Lifecycle Morgan Kaufmann Publ., 1999
- Jeff Sauro, James R. Lewis: Quantifying the User Experience Morgan Kaufmann Publ., 2016
- Karen Holtzblatt, Hugh Beyer: Contextual Design. Defining Customer-Centered Systems Morgan Kaufmann Publ., 1997

Language:

• offered only in German

Notes:

Replaces CS3201-KP04 Usability-Engineering.

Prerequisites for attending the module: - None

Prerequisites for the exam:

- Successful completion of homework assignments as stated at the beginning of the course

Exam(s):

- CS3201-L1 Usability- und UX-Engineering, Klausur, 90min, 100% der Modulnote



CS3202-KP04, CS3202 - Nonstandard Database Systems (NDB)				
Duration: Turnus of offer: Credit points:		Credit points:		
1 Semester	Semester not available anymore		4	
Course of study, specific field and te Bachelor Medical Informatics 20 Bachelor Media Informatics 20 Bachelor Computer Science 20 Bachelor Medical Informatics 2 Master Computer Science 2012 Master CLS 2010 (optional suje Bachelor CLS 2010 (optional suje Master Computer Science 2012	erm: 014 (optional subject), compute 14 (optional subject), computer 14 (optional subject), central top 011 (optional subject), Applied o 2 (optional subject), specializatio ect), computer science, Arbitrary ubject), computer science, 6th se 2 (optional subject), advanced cu	r science, 5th or 6th semest science, 5th or 6th semeste bics of computer science, 5t computer science, 4th to 6tl n field media informatics, 2 semester mester urriculum distributed inform	er r h or 6th semester h semester nd or 3rd semester nation systems, 2nd or 3rd semester	
Bachelor Computer Science 20	12 (optional subject), central top	bics of computer science, 5t	h or 6th semester	
Classes and lectures:		Workload:		
 Nonstandard Database System Nonstandard Database System 	ns (lecture, 2 SWS) ns (exercise, 1 SWS)	65 Hours private45 Hours in-class10 Hours exam p	studies room work reparation	
 Contents of teaching: introduction semistructured databases Temporal and spatial databases (temporally restricted validity, multidimensional index structures) Sequence Databases Databases for data streams (window concept) Databases for incomplete information (e.g., constraint databases) Probabilistic databases 				
Databases with answer ranking Qualification-goals/Competencies:	g (top-k queries)			
 Knowledge:Students can name models emerge if features are explaining the main features of techniques used for their prace Skills:Students can apply query sample datasets in order to sat relational data model using en to or can be implemented in S apply dedicated algorithms fo showing how index structures answers by evaluating queries Social skills:Students work in th small presentations (in lab class formalism presented in the lect 	e the main features of standard of dropped. They can describe the of respective query languages (sy tical realization. y languages for non-standard da tisfy information needs specified accoding techniques presented in QL (in particular, SQL-99). In case r query answering. Students can are built, updated, and exploited step by step and by deriving op eams to handle assignments, and eses). In addition, self-dependence ture such that students get fami	databases and, in addition, a main ideas behind non-star ntax and semantics) as wel ta models introduced in the textually in natural language the course such that they of a an SQL transformation car demonstrate how index str d for query answering. The timized query execution pla they are encouraged to pla they are encouraged to pla te is fostered by giving poir liar with data models and q	can explain which non-standard database ndard databases presented in the course by I as the most important implementation e course to retrieve desired structures from ge. Students are able to represent data in the can demonstrate how new formalisms relate not be found, students can explain and ructures help answering queries fast by participants of the course can derive query ans. resent their solution to other students in inters to query evaluation engines for various juery languages by self-controlled work.	
Grading through: • Written or oral exam as annou	nced by the examiner			
Requires:				
Databases (CS2700-KP04, CS27	/00)			
Responsible for this module: • Prof. Dr. rer. nat. habil. Ralf Mö Teacher:	ller			

Institute of Information Systems



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

Literature:

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

Language:

• offered only in German



CS3204-KP04, CS3204 - Artificial Intelligence 1 (KI1)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each summer semester		4	
Course of study, specific	field and term:			
Course of study, specific field and term: Bachelor Biophysics 2024 (optional subject), computer science, 6th semester Bachelor Robotics and Autonomous Systems 2020 (compulsory), Robotics and Autonomous Systems, 6th semester Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester Bachelor MES 2020 (optional subject), computer science / electrical engineering, 3rd semester at the earliest Bachelor Media Informatics 2019 (optional subject), computer science, 4th to 6th semester Bachelor Medizal Informatics 2019 (optional subject), computer science, 4th to 6th semester Bachelor MES 2014 (optional subject), computer science / electrical engineering, 3rd semester at the earliest Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester Bachelor Computer Science 2016 (compulsory), Canonical Specialization Web and Data Science, 6th semester Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 6th semester Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 6th semester Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 6th semester Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 6th semester Bachelor Robotics 2016 (optional subject), computer science, 5th or 6th semester Bachelor Medical Informatics 2014 (optional subject), computer science, 5th or 6th semester Bachelor Medical Informatics 2014 (optional subject), computer science, 5th or 6th semester Bachelor Media Informatics 2014 (optional subject), computer science, 5th or 6th semester Bachelor Computer Science 2014 (compulsory), specialization field robotics and automation, 6th semester Bachelor Medical Informatics 2011 (optional subject), computer scie				
Bachelor Compute	r Science 2012 (optional subject), central to	pics of computer science, 5	ith or 6th semester	
Classes and lectures:		Workload:		
Artificial IntelligenceArtificial Intelligence	icial Intelligence (lecture, 2 SWS)• 55 Hours private studiesicial Intelligence (exercise, 2 SWS)• 45 Hours in-classroom work• 20 Hours exam preparation			
Contents of teaching:				
 Part 1: Search strat introduced and exp concept of agents Part 2: Learning an (supervised and ur Part 3: Applications processing are identified 	egiesAs an introduction and a prerequisite olained. We will introduce uninformed, info will be presented. d reasoningRevision of the foundations of r supervised) are introduced. An introduction s of artificial intelligenceTypical applications ntified. Ethical issues and risks of the develo	for most of the principles o rmed, local search, adversia nathematical logic and pro n to fuzzy logic is also inclu s in the fields or robotics, m pment of artificial intellige	f artificial intelligence search strategies are al search as well as heuristic search. The obability. Principles of machine learning ded. nachine vision, and industrial image and data nce are discussed.	
Oualification-goals/Com	petencies:			
 The students are able to handle scope-oriented tutorials with a mathematical background in a team, and timely. They have developed an understanding for the benefits and disadvantages of the different search and problem solving techniques. The students are in a position to choose and apply independently appropriate algorithms for search and learning issues. They have gained an insight into the complex development of systems with artificial intelligence and the distinction of its various forms. The students have an understanding of the risks and possible technological consequences of the development of systems with strong Al. 				
Grading through:				
• portfolio exam				
Requires:				
 Analysis 2 (MA250) Algorithms and Da)-KP04, MA2500) ta Structures (CS1001-KP08, CS1001)			



Responsible for this module:
Prof. Dr. rer. nat. Floris Ernst
Teacher:
Institute for Robotics and Cognitive Systems
 MitarbeiterInnen des Instituts Prof. Dr. rer. nat. Floris Ernst
Literature:
 G. Görz (Hrsg.): Handbuch der Künstlichen Intelligenz - München: Oldenbourg Wissenschaftsverlag, 2003 C-M. Bishop: Pattern Recognition and Machine Learning - Springer Verlag, 2007 Russell/Norvig: Artificial Intelligence: a modern approach - (3rd Ed.), Prentice Hall, 2009 Mitchell: Machine Learning - McGraw-Hill, 1997 Luger: Artificial Intelligence: Structures and Strategies for Complex Problem Solving - (6th Ed.), Addison-Wesley, 2008
Language: • offered only in German
Notes:
Admission requirements for taking the module - None (the competences of the modules mentioned under Requires are needed for this module, but are not a formal prerequisite).
Admission requirements for participation in module examination(s): - Successful completion of exercises as specified at the beginning of the semester.
Moduel Exam(s): - CS3204-L1: Artificial Intelligence, Portfolio examination, 100% of the module grade
Note: The portfolio examination consists of: 70 points in the form of a written examination at the end of the semester, 15 points in the form of semester-accompanying programming tasks (group and individual performance), 15 points in the form of semester-accompanying e-tests (individual performance)



Duration:Turnus of offer:Credit points:1 Semestereach summer semester4Course of study, specific field and term:•• Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester• Bachelor MES 2020 (optional subject), computer science / electrical engineering, 3rd semester at the earliest• Bachelor Media Informatics 2020 (compulsory), media informatics, 6th semester• Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 5th or 6th semester• Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester• Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester				
1 Semester 4 Course of study, specific field and term: • • Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester • • Bachelor MES 2020 (optional subject), computer science / electrical engineering, 3rd semester at the earliest • • Bachelor Media Informatics 2020 (compulsory), media informatics, 6th semester • • Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 5th or 6th semester • • Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester • • Bachelor Computer Science 2016 (optional subject), major subject informatics. Arbitrary semester •				
 Course of study, specific field and term: Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester Bachelor MES 2020 (optional subject), computer science / electrical engineering, 3rd semester at the earliest Bachelor Media Informatics 2020 (compulsory), media informatics, 6th semester Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 5th or 6th semester Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester Bachelor Computer Science 2016 (optional subject), major subject informatics. Arbitrary semester 				
Course of study, specific field and term: Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester Bachelor MES 2020 (optional subject), computer science / electrical engineering, 3rd semester at the earliest Bachelor Media Informatics 2020 (compulsory), media informatics, 6th semester Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 5th or 6th semester Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester Bachelor 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 Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester Bachelor Medical Informatics 2014 (optional subject), computer science, 5th or 6th semester Bachelor Medical Informatics 2014 (compulsory), media informatics, 6th semester Bachelor Computer Science 2014 (optional subject), central topics of computer science, 5th or 6th semester Bachelor Medical Informatics 2011 (optional subject), computer science, 4th to 6th semester Bachelor Medical Informatics 2011 (optional subject), computer science, 4th to 6th semester Master Computer Science 2012 (optional subject), computer science, 4th to 6th semester Bachelor Medical Informatics 2011 (optional subject), computer science, 4th to 6th semester Bachelor Medical Informatics 2011 (optional subject), computer science, 4th to 6th semester Bachelor Medical Informatics 2012 (optional subject), computer science, 5th or 6th semester Bachelor Computer Science 2012 (optional subject), central				
Classes and lectures: Workload: • Computer Graphics (lecture, 2 SWS) • 55 Hours private studies • Computer Graphics (exercise, 1 SWS) • 45 Hours in-classroom work • 20 Hours exam preparation • 20 Hours exam preparation Contents of teaching: • 6eometric transformations in 2D and 3D • Homogeneous coordinates • 17ansformations between Cartesian coordinate systems • Planar and perspective projections • Polygonal models • Illumination models and shading methods • Texture Mapping • Culling and clipping • Hidden line and surface removal • Raster graphics algorithms • Ray tracing • Shadows, reflections and transparency • Functions and transparency				
Qualification-goals/Competencies: • Students know the basic concepts, algorithms and methods in computer graphics • They are able to implement and apply principle algorithms • They are able to explain the learned techniques and to assess their possibilities and limitations				
Grading through: • written exam				
Requires: • Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500) • Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000) Responsible for this module:				



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



CS3810 - Image and Signal Processing in Medicine 2 (MBS2)					
Duration:	Turnus of offer:		Credit points:		
1 Semester	irregularly		4		
 Course of study, specific field and term: Bachelor Medical Informatics 2011 (optional subject), medical computer science, 4th to 6th semester 					
Classes and lectures:		Workload:			
 Image and Signal Processing in Medicine 2 (lecture, 2 SWS) Image and Signal Processing in Medicine 2 (exercise, 1 SWS) Structure 55 Hours private studies 45 Hours in-classroom work 20 Hours exam preparation 			studies room work reparation		
Contents of teaching:					
 Advanced methods for the combined signal and image analysis Methods for the automatic determination of anatomical landmarks Methods for finding correspondences in medical image data Methods of non-linear image registration Fusion of medical imaging data and image-based motion field estimation Methods for pattern recognition in medical data Methods for extraction and selection of image features Feature-based segmentation using statistical classifiers and neural networks Methods for image-based generation of finite element models Image-based modeling and simulation of physiological processes Fxamples 					
 Qualification-goals/Competencies: Knowledge of advanced methods for combined analysis of signal and image sequences in medicine Knowledge of advanced methods for image registration, image recognition and image-based modeling Ability to evaluate, select and apply appropriate methods and algorithms Advanced overview of the scope of medical image processing with many examples Advanced ability to process and analyze medical images 					
Grading through:Written or oral exam as announced by the examiner					
Requires: • Medical Imaging, Image and Signal Computing (ME3000)					
Responsible for this module:					
Prof. Dr. rer. nat. habil. Heinz Handels					
Institute of Medical Informatics					
Prof. Dr. ror. pat. habil. Heinz Handelr					
דוסו. סו. דפו. המנ. המטוו. הפוחב המחעפוא					
 Literature: H. Handels: Medizinische Bildverarbeitung - Stuttgart: Vieweg & Teubner 2009 M. Sonka, V. Hlavac, R. Boyle: Image Processing, Analysis and Machine Vision - 2nd edition. Pacific Grove: PWS Publishing 1998 					
• offered only in German					





CS3820 - Decision support in medicine (EntscheidM)						
Duration:	Turnus of offer:		Credit points:			
1 Semester	irregularly		4			
Course of study, specific field and • Bachelor Medical Informatics	 Course of study, specific field and term: Bachelor Medical Informatics 2011 (optional subject), medical computer science, 4th to 6th semester 					
Classes and lectures:Workload:• Decision support in medicine (lecture, 2 SWS)• 55 Hours private studies• Decision support in medicine (exercise, 1 SWS)• 45 Hours in-classroom work• 20 Hours exam preparation						
 Contents of teaching: Decision support in evidence-based medicine (EbM) Information systems versus knowledge-based systems From the published knowledge (including MEDLINE) via reviews (including Cochrane) and guidlines to IT-based interpretation (GLIF & Arden Syntax) in knowledge-based systems Decision support in consideration of complexity, uncertainty and incompleteness Basic methods from artificial intelligence to represent and infer knowledge Methods for decision support in medicine: declarative approaches, machine learning approches, case based reasoning and expert systems Data Warehouse and Data Mining - Methods for identifying valid, novel, potentially useful and understandable pattern in datasets. Examples: effective provision of knowledge on clinical work station, scores and diagnostical tests, drug safety, expert systems for diagnostic in laboratories Other issues with regard to the applicability of systems for decision support in practice, including knowledge acquisition, interpretation of patient data accontance of computer aided decision support in generative and pursor. 						
 Qualification-goals/Competencies: Insight into processes and applications for decision support in medicine Knowledge of various procedures for representation and processing of medical knowledge Knowledge of the essential conditions with regard to the initialisation of decision support systems in the clinical application 						
Grading through:Written or oral exam as announced by the examiner						
Responsible for this module: • Prof. Dr. rer. nat. habil. Heinz Handels Teacher: • Institute of Medical Informatics • Prof. Dr. rer. nat. habil. Heinz Handels						
 Literature: Th. Lehmann: Handbuch der Medizinischen Informatik - 2. Auflage: München: Hanser 2004 C. Spreckelsen, K. Spitzer: Wissensbasen und Expertensysteme in der Medizin - Wiesbaden: Vieweg+Teubner, 2008 C. Beierle, G. Kern-Isberner: Methoden wissensbasierter Systeme - 4. Auflage, Wiesbaden: Vieweg+Teubner, 2008 P. Haas, B. Breil: Wissensmanagement und wissensbasierte Systeme - Berlin: Springer, 2012 SAS: Data Mining Using SAS Enterprise Miner: A Case Study Approach - 2nd Edition, SAS Publishing, 2003 						
offered only in German						



CS3830-KP04, CS3830 - Programming for Medical Image Processing in C++ (PmBV)					
Duration: Turnus of offer: Credit p		Credit points:			
1 Semester each summer semester			4 (Typ B)		
 Course of study, specific field and term: Bachelor MES 2014 (optional subject), medical engineering science, 4th or 6th semester Master Medical Informatics 2014 (optional subject), medical image processing, 1st or 2nd semester Bachelor Medical Informatics 2014 (optional subject), medical computer science, 5th or 6th semester Bachelor Medical Informatics 2011 (optional subject), medical computer science, 4th to 6th semester 					
Classes and lectures: Workload: • Programming for Medical Image Processing in C++ (lecture, 1 SWS) • 70 Hours private studies • Programming for Medical Image Processing in C++ (practical course, 2 SWS) • 5 Hours oral presentation and discussion (including preparation)			studies sroom work sentation and discussion (including		
 Contents of teaching: Introduction to C++ programming for medical image processing File formats of medical data and data structure/types Vectors, Standard Template Library, Pairs and Tuples Class objects, functions and methods Loops, also in C++11, lambda functions Use of programming libraries (Eigen) Implementation of filters for medical image processing Dimensionality reduction using PCA Search and cluster trees for image processing Patch-based non-local means segmentation Fast-Fourier transform for template matching Integration of C++ in MATLAB (mex) Efficient programming for 3d medical images Parallel and SIMD programming techniques in C++ Solve practical project in a team 					
 Qualification-goals/Competencies: Students understand the specific challenges of programming for medical image processing. They know the basics of object orientated programming. They are able to implement local and regional pixel operators (filter, etc) independently. They know functions from STL and current trends in C++. They are proficient in solving large problems in limited time. They can design, implement and test programme code independently. They are able to develop practical algorithms for medical image processing based on theoretical concepts. They can tackle large scale problems together in teams. 					
Grading through: • continuous, successful participation in practical course					
Responsible for this module: Prof. Dr. rer. nat. habil. Heinz Handels Teacher: Institute of Medical Informatics Prof. Dr. Mattias Heinrich 					
Literature: • Lippman: C++ Primer - Addison-Wesley Longman, Amsterdam					
Language:					



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German and English skills required

Notes:

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



LS1100-INF - Basic Chemistry (ChemINF)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each winter semester		4	
 Course of study, specific field and term: Bachelor MES 2014 (optional subject), mathematics / natural sciences, 3rd or 5th semester Bachelor Computer Science 2014 (compulsory), specialization field bioinformatics, 3rd semester Bachelor MES 2011 (optional subject), optional subject medical engineering science, 3rd or 5th semester Bachelor Medical Informatics 2011 (optional subject), bioinformatics, 4th to 6th semester Bachelor Computer Science 2012 (compulsory), specialization field bioinformatics, 3rd semester 				
Classes and lectures:		Workload:		
 Basic Chemistry (lecture, 2 SWS) Basic Chemistry (exercise, 1 SWS) 		 55 Hours private studies 45 Hours in-classroom work 20 Hours exam preparation 		
Contents of teaching: Organisation of matter and the periodic table of the elements Chemical bonds, molecules and lons Chemical formula and stoichiometry The threedimensional structure of molecules: From the VSEPR model to molecular orbitals Special properties of water Chemical Equilibrium Acids and Bases Redox reactions and electrochemistry Complexes and metal-ligand bonds Interactions between mater and radiation - Spectroscopy Thermodynamics Chemical Kinetics Oualification-goals/Competencies: Understanding basic chemical concepts Basics of anorganic chemistry				
Grading through: written exam 				
Responsible for this module: • PD Dr. phil. nat. Thomas Weimar Teacher: • Institute of Chemistry and Metabolomics • Dr. rer. nat. Kerstin Lüdtke-Buzug • PD Dr. phil. nat. Thomas Weimar				
Literature: • Schmuck et al.: Chemie für Mediziner - Pearson Studium • Binnewies et al.: Allgemeine und Anorganische Chemie - Spektrum				
Language: • offered only in German				



LS3100 - Molecular Genetics (MolGen)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each winter semester		4	
Course of study, specific field and • Bachelor Medical Informatic • Bachelor Computer Science	d term: s 2011 (optional subject), bioinform 2012 (compulsory), specialization fi	atics, 4th to 6th semester eld bioinformatics, 5th ser	nester	
 Classes and lectures: Molecular genetics for computer scientists (lecture, 1 SWS) Molecular genetics for computer scientists (practical course, 2 SWS) 		Workload: • 60 Hours private studies • 45 Hours in-classroom work • 15 Hours exam preparation		
Contents of teaching: Structure of DNA Causes of mutations Generation of genetically m PCR, ligation of DNA into pl Molecular evolution of DNA 	odified bacteria (Designs of the exp asmids, transformation of bacteria, r and its analysis by bioinformatical r	eriment at the computer, restriction analysis, sequer methods	isolation of DNA, restriction cutting of DNA, ncing of DNA)	
Qualification-goals/Competencie Ability, to understand and r Basic practical skills in mole 	s: eproduce theoretical knowledge in cular genetics including the use of b	molecular genetics and ap pioinformatics in the daily	oply it in the following studies laboratory routine	
Grading through: • written exam				
Requires: • Biology (LS2500-KP04, LS25	00)			
Responsible for this module: • PD Dr. rer. nat. Bärbel Kunzer Teacher: • Institute for Biology • PD Dr. rer. nat. Bärbel Kunzer • Prof. Dr. rer. nat. Enno Hartm • Dr. rer. nat. Nicole Sommer	e nann			
Literature: • Campbell & Reece: Biologie • Purves, Sadava, Orians, Helle • Markl: Biologie - Klett • T.A. Brown: Gentechnologie	- Pearson er: Biologie - Spektrum e für Einsteiger - Spektrum			
Language: • offered only in German				
Notes:				





The module is passed if:

- 80% attendance, both in the practical part and in the lecture part

- submission of a complete test protocol

- Passing the written exam; more than 50% of the maximum number of points must be achieved

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

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



MA2214-KP04, MA2214 - Clinical Studies (KlinStud)					
Duration:	Turnus of offer:		Credit points:		
1 Semester	each winter semester		4		
 Course of study, specific field and term: Bachelor CLS 2023 (compulsory), mathematics, 3rd or 5th semester Master Nutritional Medicine 2023 (compulsory), medical computer science, 1st semester Bachelor Medical Informatics 2019 (optional subject), medical computer science, 4th to 6th semester Bachelor CLS 2016 (compulsory), mathematics, 3rd or 5th semester Master Nutritional Medicine 2019 (compulsory), medical computer science, 1st semester Bachelor Medical Informatics 2019 (compulsory), medical computer science, 1st semester Bachelor Medical Informatics 2014 (optional subject), medical computer science, 5th or 6th semester Bachelor Medical Informatics 2011 (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 CLS 2010 (compulsory), mathematics, 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: Definition of a clinical study according to the German Drug Law, classification of clinical studies, clinical development Basic principles of clinical trials and measures against bias Regulations and study documents Development of a clinical study, especially a study protocol Contents of a study protocol Link to health economics Further topics like Special study designs Advanced statistical analyses Report and publication Systematic overview and meta-analyses Data management and system validation Professional fields in clinical studies (study statistics, data management, monitoring, quality management, pharmacovigilance, project management) Qualification-goals/Competencies: Students can describe the regulatory framework of clinical trials with drugs. They can eschibe 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 represent study protocol. They can explain the basic principles of clinical trials and measures to achieve these basic principles. They can explain the basic principles of simple clinical studies. Students can assign studies and their key points to the stages of clinical development. They can explain different study dosigns. 					
Grading through:					
portrolio 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.


MA34	MA3400-KP04, MA3400 - Biomathematics (Biomathe)			
Duration:	Turnus of offer:		Credit points:	
1 Semester	each winter semester		4	
Course of study, specific field and term:				
Course of study, specific field and term: Master Molecular Life Science 2023 (optional subject), mathematics / computer science, 1st semester Bachelor MES 2020 (optional subject), mathematics / natural sciences, 3rd semester at the earliest Bachelor Robotics and Autonomous Systems 2020 (optional subject), mathematics, 5th or 6th semester Bachelor Medical Informatics 2014 (optional subject), medical computer science, 5th or 6th semester Bachelor MES 2014 (optional subject), mathematics / natural sciences, 3rd or 5th semester Bachelor MES 2014 (optional subject), mathematics / natural sciences, 3rd or 5th semester Bachelor Computer Science 2014 (compulsory), specialization field bioinformatics, 5th semester Master MES 2011 (optional subject), mathematics, 1st semester Bachelor Medical Informatics 2011 (optional subject), bioinformatics, 4th to 6th semester Bachelor MES 2011 (optional subject), mathematics, 5th semester Bachelor MES 2011 (optional subject), specialization field medical informatics, 3rd semester Bachelor MES 2011 (optional subject), mathematics, 5th semester 				
Classes and lectures:		Workload:		
 Biomathematics (lecture, 2 SWS) Biomathematics (exercise, 1 SWS) 		 55 Hours private 45 Hours in-class 20 Hours example 	studies and exercises proom work	
 Existence and uniqueness theorems Dependence of solutions on initial co Linear systems (in particular with coi Higher-Order linear differential equa Qualitative theory of nonlinear syste In accordance to the rules of GSP of Qualification-goals/Competencies:	 Existence and uniqueness theorems Dependence of solutions on initial conditions Linear systems (in particular with constant coefficients) Higher-Order linear differential equations Qualitative theory of nonlinear systems In accordance to the rules of GSP of UzL 			
 Students are able to explain basic not Based on examples, students are able Based on theorems, students are able Students are able to find explicit solution Students are able to explain how sol Students are able to present importation 	 Qualification-goals/Competencies: Students are able to explain basic notions from the theory of ordinarydifferential equations. Based on examples, students are able to explain Based on theorems, students are able to give conditions under which Students are able to find explicit solutions of simple differential equations. Students are able to explain how solutions of differential equations can beanalysed qualitatively. Students are able to present important models of the natural sciences which canbe analysed by differential equations. 			
Grading through: • written exam				
Requires: • Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500) • Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000) • Analysis 2 (MA2500-KP04, MA2500) • Analysis 1 (MA2000-KP08, MA2000)				
Responsible for this module: • PD Dr. rer. nat. Christian Bey Teacher: • Institute for Mathematics • PD Dr. rer. nat. Christian Bey				
Literature:				
 G. Birkhoff, 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





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Credit points:				
4				
 Course of study, specific field and term: Bachelor Robotics and Autonomous Systems 2016 (compulsory), computer science, 5th semester Bachelor Medical Informatics 2011 (compulsory), computer science, 5th semester Master CLS 2010 (compulsory), mathematics, 1st semester Bachelor Computer Science 2012 (compulsory), foundations of computer science, 5th semester 				
Workload:				
55 Hours private studies45 Hours in-classroom work20 Hours exam preparation				
 20 Hours exam preparation Contents of teaching: Linear time-invariant systems Impulse response Convolution Fourier transform Transfer function Correlation and energy density of deterministic signals Sampling Discrete-time signals and systems Discrete-time Fourier transform z-Transform FIR and IIR filters Block diagrams FIR filter design Discrete Fourier transform (DFT) Fast Fourier transform (FFT) 				
 Qualification-goals/Competencies: Students are able to explain the fundamentals of linear system theory. They are able to describe the basic elements of signal processing. They will have a command of methods for the description and analysis of continuous-time and discrete-time signals and systems. They are able to design digital filters and know various structures for their implementation. They are able to explain the basic techniques for describing and processing of random signals. 				
Grading through:Written or oral exam as announced by the examiner				
Responsible for this module: • Prof. DrIng. Alfred Mertins Teacher: • Institute for Signal Processing • Prof. DrIng. Alfred Mertins Literature: • A. Mertins: Signaltheorie: Grundlagen der Signalbeschreibung, Filterbänke, Wavelets, Zeit-Frequenz-Analyse, Parameter- und Signalschätzung - Springer-Vieweg, 3. Auflage, 2013				



Language:

• offered only in German

Notes:

Prerequisites for attending the module: - None

Prerequisites for the exam:

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

Modul exam:

- CS3100-L1: Signal Processing, written exam, 120 Min,. 100% of modul grade



CS3310 - Image and Signal Processing in Medicine 1 (MBS)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each winter semester		4	
Course of study, specific field and terr • Bachelor MES 2011 (compulsory) • Bachelor Medical Informatics 201	n: , medical engineering science, 1 (compulsory), medical comp	5th semester uter science, 5th semester		
Classes and lectures:		Workload:		
 Image and signal processing in medicine 1 (lecture, 2 SWS) Image and signal processing in medicine 1 (exercise, 1 SWS) 55 Hours private studies 45 Hours in-classroom work 20 Hours exam preparation 			studies sroom work preparation	
Contents of teaching:				
 Motivation, principles and applications of medical image and signal processing Signal processing in electrocardiography (ECG) Signal processing in the electroencephalogram (EEG) Structure and formats of medical images Fundamentals of pattern recognition (segmentation, feature extraction, classification, interpretation) Histograms and image transformations Image filtering with local operators Segmentation: thresholding, region growing Morphological operators Application and evaluation of segmentation methods Basic methods for the visualization of medical images and image sequences Basic methods of image registration: rigid image registration Combined signal and image analysis in functional MRI Application examples 				
 Qualification-goals/Competencies: Basic knowledge of methods and procedures of medical image processing Ability to evaluate and apply the application methods and algorithms in the respective phase of image processing pipelines Overview of the scope of medical image processing by many examples 				
 Capacity for communication and Knowledge of methods for combination 	processing of medical image c bined analysis of signal and image c	Jata age sequences in medicine	2	
Grading through: • written exam				
Is requisite for: • Image and Signal Processing in N	Лedicine 2 (CS3810)			
Responsible for this module: Prof. Dr. rer. nat. habil. Heinz Handels Teacher: Institute of Medical Informatics Prof. Dr. rer. nat. habil. Heinz Handels 				
Literature:				
 H. Handels: Medizinische Bildverarbeitung - Stuttgart: Vieweg & Teubner 2009 T. Lehmann: Handbuch der Medizinischen Informatik - München: Hanser 2004 M. Sonka, V. Hlavac, R. Boyle: Image Processing, Analysis and Machine Vision - 2nd edition. Pacific Grove: PWS Publishing 1998 				
• offered only in German				



C	S3330 - Practical Medi	cal Informatics (ProjMI)
Duration:	Turnus of offer: Credit points:	
1 Semester	each winter semester	8 (Тур В)
Course of study, specific field and term: • Bachelor Medical Informatics 2011 (compulsory), medical comp	uter science, 5th semester
Classes and lectures: • Projektpraktikum Medizinische Info	rmatik (team work, 6 SWS)	 Workload: 110 Hours work on project 90 Hours group work 30 Hours written report 10 Hours oral presentation (including preparation)
 Contents of teaching: Introduction to required methods a Planning and execution of a softwa in efficient teams in compliance wit The project is separated into sub-pr 	nd software tools, relevant t re /hardware project, from ra h standards and deadlines. ojects with topics chosen fro	o the project equirements analysis to productive use. Self-organization and working om both eHealth and medical imaging fields.
Qualification-goals/Competencies: Enhancing practical knowledge and Acquisition of skills for the use of sc Ability to identify and phrase the re Ability to analyze complex problem Ability to estimate the project effort Ability to integrate and merge sub- Ability to document the work and s 	I skills in software developm oftware tools and practical in quirements for a software sy s, to be divided into sub-tas t, plan the project schedule a parts to the overall solution ource code and to present re	ent in the areas of e-Health and medicalimage processing. nplementation of medical standards for the processing of medical data. /stem under discussion with target groups. ks and implement in an efficient implementation. and use resources purposeful. and to ensure the quality. esults.
Grading through: • successful addressing of the project	goals	
Requires: • Databases (CS2700-KP04, CS2700) • Algorithms and Data Structures (CS • Software Engineering I (CS2300) • Programming (CS1000) • Informatics in Health Care - eHealth • Introduction to Medical Informatics	1001-KP08, CS1001) (CS3300-MI) (CS1300-KP04, CS1300)	
Responsible for this module: • Prof. Dr. rer. nat. habil. Heinz Hande Teacher: • Institute of Medical Informatics • Prof. Dr. rer. nat. habil. Heinz Hande • Prof. Dr. rer. nat. habil. Josef Ingene	ls Is rf	
offered only in German		



CS3703-KP04, CS	53703 - Bachelor Sem	inar Medical Informa	itics (BachSemMI)	
Duration:	Turnus of offer:		Credit points:	
1 Semester	each semester		4 (Тур В)	
 Course of study, specific field and term: Bachelor Medical Informatics 2019 (compulsory), interdisciplinary competence, 5th semester Bachelor Medical Informatics 2014 (compulsory), interdisciplinary competence, 5th semester Bachelor Medical Informatics 2011 (compulsory), interdisciplinary competence, 5th semester 				
Classes and lectures: • Seminar (seminar, 2 SWS)		Workload: • 40 Hours written • 35 Hours private • 30 Hours in-class • 15 Hours oral pre	report studies room work esentation (including preparation)	
 Contents of teaching: Training in a scientific topic Processing a scientific problem and i Presentation and discussion of the topic 	ts solution methods opic in English			
 Qualification-goals/Competencies: The students are able to analyze, judge and develop a scientific topic. They are able to present the results in a written documentation and in a talk in an scientific way The are able to present and discuss a scientific topic in English. They are able to classify and differentiate the topic in the wider academic context. They improve their language competency. 				
Grading through: oral presentation term paper 				
Responsible for this module: • Studiengangsleitung Medizinische Informatik Teacher: • Institute of Medical Informatics				
 Literature: Subject and literature are determined individually: Participants should have the task in a timely manner, i. At least 1 MONTH before the beginning of the event, discuss with the lecturer: 				
Language: • offered only in English				
Notes: Admission requirements for taking the module: - None Admission requirements for participation in module examination(s): - Successful participation in the seminar incl. elaboration, presentation, contributions to the discussion according to the requirements at the beginning of the semester. Module Exam(s): - CS3703-L1: Bachelor Seminar Medical Informatics, seminar, ungraded				



ME3000 - M	edical Imaging, Image	and Signal Computii	ng (MEDBGBV)	
Duration:	Turnus of offer:		Credit points:	
1 Semester	each winter semester		8	
Course of study, specific field and term: • Bachelor MES 2011 (compulsory), n • Bachelor Medical Informatics 2011	nedical engineering science, (compulsory), medical comp	5th semester uter science, 5th semester		
Classes and lectures:		Workload:		
 Module part CS3310: Image and Signature 1 (course, 3 SWS) Module part ME3100: Medical Image 	gnal Processing in Medicine jing (course, 3 SWS)	 110 Hours privat 90 Hours in-class 40 Hours exam p 	e studies room work reparation	
Contents of teaching: • See description of module parts				
Qualification-goals/Competencies: • See description of module parts				
Grading through: • written exam	Grading through: written exam 			
Responsible for this module:				
Prof. Dr. rer. nat. Thorsten Buzug				
Teacher: • Institute of Medical Engineering • Institute of Medical Informatics				
 Prof. Dr. rer. nat. Martin Koch 				
Language:German and English skills required				



	ME3100 - Medica	al Imaging (MBG)			
Duration:	Turnus of offer:		Credit points:		
1 Semester	each winter semester		4		
Course of study, specific field and term: • Bachelor MES 2011 (compulsory), me • Bachelor Medical Informatics 2011 (c	 Course of study, specific field and term: Bachelor MES 2011 (compulsory), medical engineering science, 5th semester Bachelor Medical Informatics 2011 (compulsory), medical computer science, 5th semester 				
Classes and lectures:		Workload:			
 Medical Imaging (lecture, 2 SWS) Medical Imaging (practical course, 1 	SWS)	 55 Hours private 45 Hours in-class 20 Hours exam private 	studies room work reparation		
Contents of teaching: • Introduction to the theory of imaging • Ultrasound imaging • Conventional X-ray imaging, Comput • Magnetic Resonance Imaging	g systems ted Tomography				
Qualification-goals/Competencies:					
 Magnetic Resonance imaging Qualification-goals/Competencies: The students can characterise linear translation-invariant imaging systems by means of impulse response and transfer function. They can explain the Nyquist-Shannon theorem and justify its validity. They can describe what is meant by spatial resolution of an imaging system. They can describe the physical foundations of ultrasound imaging. They can explain the physical foundations of ultrasound imaging. They can escribe the behaviour of ultrasound waves at tissue borders. They can leasen the fundamental limit to spatial resolution in US. They can elucidate how technical parameters are chosen for a given target to be imaged. They can elucidate how technical parameters are chosen for a given target to be imaged. They can elucidate how technical parameters are chosen for a given target to be imaged. They can elucidate how technical parameters are chosen for a given target to be imaged. They can explain the physical and technical foundations of X-ray generation. They can explain the physical and technical K-ray source. They can describe why important US image artefacts occur. They can describe the most important interaction processes between X-rays and matter. They can describe the most important interaction processes between X-rays and matter. They can describe the influence of technical parameters in X-ray imaging systems. They can describe how spatial resolution is achieved in NMR imaging. They can explain the physical foundations of nuclear magnetic resonance (NMR). They can describe how different types of radio frequency echoes in NMR. They can explain the physical foundations is Achieved in NMR imaging. They can explain the concept of k-space. They can explain the physical foundations is achieved in NMR imaging. <					
Grading through: written exam					
 written exam Responsible for this module: Prof. Dr. rer. nat. Martin Koch Teacher: Institute of Medical Engineering Prof. Dr. rer. nat. Martin Koch 					



Literature:

- O. Dössel: Bildgebende Verfahren in der Medizin Springer, Berlin 2000
- H. Morneburg (Hrsg.): Bildgebende Systeme für die medizinische Diagnostik. 3. Aufl. Publicis MCD Verlag, München 1995

Language:

• German and English skills required



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	PS3700 - Presentation	and Documentation (F	PundD)	
Duration:	Turnus of offer:		Credit points:	
1 Semester	each winter semester		3 (Тур В)	
Course of study, specific field and • Bachelor Medical Informatic • Bachelor Computer Science	d term: s 2011 (compulsory), interdiscipl 2012 (compulsory), interdiscipli	linary competence, 5th seme nary competence, 5th semes	ester ter	
Classes and lectures: • Presentation and documen	Classes and lectures: Workload: • Presentation and documentation (exercise, 2 SWS) • 60 Hours private studies • 30 Hours in-classroom work			
Contents of teaching: • Techniques of scientific inve- • Techniques of scientific wri- • Bibliographical reference ar • Desktop publishing: LaTeX, • Structuring of Talks • Skills for talks • LaTeX, Impress, and Powerg	estigation ting nd citations in scientific papers OpenOffice, MS Word point presentations - Do's and do	n'ts		
Qualification-goals/Competencie • The Students know about t • They obtained some insigh • They are able to apply their	es: he most important presentation t into technologies about scienti r skills in talks and in writing scien	technologies fic writing and documentation ntific papers	on	
Grading through: • participation in discussions				
Responsible for this module: • PD Dr. Gerhard Buntrock Teacher: • Institute for Theoretical Cor • Institute of Software Techno • PD Dr. Gerhard Buntrock • Prof. Dr. rer. nat. Till Tantau • Prof. Dr. rer. nat. Amir Mada	nputer Science blogy and Programming Languag	ges		
Literature: • Matthias Karmasin, Rainer F Language: • offered only in German	Ribing: Die Gestaltung wissensch	aftlicher Arbeiten - UTB 2011	l	



CS3203 - Image processing (Bildverarb)			
Duration:	Turnus of offer:		Credit points:
1 Semester	each summer semester		4
Course of study, specific field and term: • Bachelor Computer Science 2012 (o • Bachelor Medical Informatics 2011 (o • Master CLS 2010 (compulsory), math • Bachelor Computer Science 2012 (co • Bachelor Computer Science 2012 (o	ptional subject), specializati compulsory), computer scie nematics, 2nd semester ompulsory), specialization fi ptional subject), central top	on field bioinformatics, 6tl nce, 6th semester eld robotics and automati ics of computer science, 5t	n semester on, 6th semester ih or 6th semester
Classes and lectures:		Workload:	
 Image processing (lecture, 2 SWS) Image processing (exercise, 1 SWS) 		 55 Hours private 45 Hours in-class 20 Hours exam p 	studies croom work preparation
Contents of teaching:			
 Introduction, interest of visual information Fourier transformation Sampling and sampling theorem Filtering Image enhancement Edge detection Multiresolution concepts: Gaussian and Laplacian Pyramid, wavelets Principles of image compression Segmentation Morphological image processing 			
Qualification-goals/Competencies:			
 Students will have basic knowledge They are able to describe the main t They are able to apply the learned p 	of two-dimensional system techniques for image analys principles in practice.	theory. is and image enhancemer	ıt.
Grading through:Written or oral exam as announced by the examiner			
Requires: • Signal processing (CS3100-KP04) • Analysis 1 (MA2000-KP08, MA2000)			
Responsible for this module: • Prof. DrIng. Alfred Mertins Teacher: • Institute for Signal Processing • Prof. DrIng. Alfred Mertins			
Literature:			
 A. K. Jain: Fundamentals of Digital Ir Rafael C. Gonzalez, Richard E. Wood 	mage Processing - Prentice s: Digital Image Processing	Hall, 1989 - Prentice Hall 2003	
Language: • offered only in German			



Duration:		
Duration:	Turnus of oner:	
1 Semester	each summer semester	_, З (Тур В)
Course of study, specific field and to Bachelor Medical Informatics Bachelor Medical Informatics Bachelor Medical Informatics	term: 2019 (compulsory), interdisciplina 2014 (compulsory), interdisciplina 2011 (compulsory), interdisciplina	ary competence, 6th semester ary competence, 6th semester ary competence, 6th semester
Classes and lectures: • Social Aspects of Medical Info • Social Aspects of Medical Info	rmatics (lecture, 1 SWS) rmatics (seminar, 1 SWS)	Workload: • 40 Hours written report • 30 Hours in-classroom work • 20 Hours private studies
Contents of teaching: • History and philosophy of tec • Theories of technolution (how • Critique and assessment of te • Fields of application of inform • Ethical and societal aspects o • Data security, cultural and ae	hnology and informatics in gene v and when do innovations emer chnology, technology assessmen nation technology in medicine f information technology sthetical aspects of digital media	ral ge?) t
 Students are able to describe They can depict pivotal stage They are capable to identify or discuss them critically. They have an understanding knowledge to case studies. They master to research, interventional to the the communication 	and explain basic concepts, theo s and controversies in the historic juestions of social acceptability o of the philosophical and cultural pret, and analyze critically scient n competency to analyze and pre	ries, and methods of history of technology studies. cal development of medical informatics. f information technology, to carve out their different implications, and to implications of information technology, and are able to apply this ific literature on the module's topics. esent societal aspects of technological issues in oral and written form.
Grading through: • presentation • Written report • continuous, successful partici	pation in course	
Responsible for this module: • Prof. Dr. med. Cornelius Borck Teacher: • Institute of Medical Information • Institute for History of Medicial • Prof. Dr. med. Cornelius Borck • Prof. Dr. rer. nat. Burghard We • Prof. Dr. rer. nat. Burghard We • Prof. Dr. rer. nat. habil. Heinz I • Prof. Dr. phil. Christoph Rehm • DiplInform. Dr. med. Jan-Him • Dr. phil. nat. Thorsten Kohl • Dr. phil. Daniela Zetti	iss Hand Science Studies Handels ann-Sutter rich Wrage	
Literature: • Kramme R (Hrsg.): Medizinted 2011 • Orland B (Hrsg): Artifizielle Kö Chronos 2005 • Horx M: Technolution. Wie ur	hnik: Verfahren Systeme Infor rper lebendige Technik: Techni sere Zukunft sich entwickelt - Fra	mationsverarbeitung - 4. Aufl. Berlin, Heidelberg, New York: Springer sche Modellierungen des Körpers in historischer Perspektive - Zürich: ankfurt: Campus 2008



Language:

• offered only in German

Notes:

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- Successful and regular participation in the seminar incl. elaboration, presentation, contributions to the discussion as specified at the beginning of the semester.

Module Exam(s):

- CS3800-L1: Social Aspects of Medical Informatics, ungraded seminar



CS3991-KP15, CS3991 - Bachelor Thesis Medical Informatics (BScMI)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each semester		15	
Course of study, specific field and terr • Bachelor Medical Informatics 201 • Bachelor Medical Informatics 201 • Bachelor Medical Informatics 201	n: 19 (compulsory), medical comp 14 (compulsory), medical comp 11 (compulsory), medical comp	uter science, 6th semester uter science, 6th semester uter science, 6th semester		
Classes and lectures:		Workload:		
 Bachelor Thesis Medical Informa SWS) Colloquium (presentation (incl. p 	tics (supervised self studies, 1 preparation), 1 SWS)	 360 Hours resear 90 Hours oral preparation) 	rch for and write up of a thesis esentation and discussion (including	
Contents of teaching:				
 Independent scientific work on a Scientific presentation about the 	a limited task of medical inform e problem and the solution dev	atisc and its applications eloped		
Qualification-goals/Competencies:				
 Students are able to solve a limit They have the expertise to plan, They can present complex inforr They are experts for a clearly def 	ed task of a scientific problem organize and carry out a projec nation in written and oral form. ined topic.	with the means of their dis ct work.	scipline.	
Grading through: • Written report • colloquium				
Responsible for this module:				
Studiengangsleitung Medizinise	che Informatik			
Teacher:				
 Institutes of the Department of Computer Science/ Engineering Alle prüfungsberechtigten Dozentinnen/Dozenten des Studienganges 				
l iterature:				
• :				
l anguage:				
thesis can be written in German	or English			
Notes:				
Admission requirements for taking - see study programme regulations	the module: s (e.g. certain minimum CP achi	eved).		
Admission requirements for partici - none	pation in module examination(s):		
Module Exam(s): - CS3991-L1: Bachelor thesis with c	olloquium, 100% of the module	e grade.		
Of the credit points of the module, execution of the colloquium.	12 credit points are awarded for	or the actual thesis, the rei	maining credit points for the preparation and	



Λ	MZ3160 - Radiologie, Nuklearmedizin, Strahlentherapie (RNS)			
Duration:	Turnus of offer:	Turnus of offer: Credit points:		
1 Semester	each summer semester		3	
Course of study, specific field and term: • Bachelor Medical Informatics 2011 (compulsory), medical computer science, 6th semester • Bachelor MES 2011 (compulsory), medicine, 6th semester				
Classes and lectures:		Workload:		
 Radiology, Nuclearmedici 	 Radiology, Nuclearmedicine, Radiotherapy (lecture, 2 SWS) 30 Hours in-classroom work 20 Hours exam preparation 20 Hours group work 20 Hours private studies 		room work reparation vork studies	
Contents of teaching: • • • • • • • Qualification-goals/Competence • •	ies:			
• written exam				
Responsible for this module: • Prof. Dr. med. Jörg Barkha Teacher: • • • • • • • • • • • • •	usen ver mm st nn			
Literature: • : • : • :				



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Language:

• offered only in German
