

UNIVERSITÄT ZU LÜBECK

Module Guide for the Study Path

Bachelor Robotics and Autonomous Systems 2020

Version from 14. April 2025



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CS1000-KP10, CS1000SJ14 - Introduction to Programming (EinfProg14)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each winter semester		10	
Course of study, specific field and term Bachelor Media Informatics 2020 (Bachelor Computer Science 2019 Bachelor Robotics and Autonomo Bachelor Computer Science 2016 Bachelor Robotics and Autonomo Bachelor IT-Security 2016 (compul Bachelor Media Informatics 2014 (Bachelor Computer Science 2014	: compulsory: aptitude test), co (compulsory: aptitude test), fo us Systems 2020 (compulsor (compulsory: aptitude test), fo us Systems 2016 (compulsory sory: aptitude test), compute compulsory: aptitude test), co	omputer science, 1st semes oundations of computer sc y), foundations of compute oundations of computer sc r), computer science, 1st se r science, 1st semester omputer science, 1st semes oundations of computer sc	ster ience, 1st semester er science, 1st semester ience, 1st semester mester ster ience, 1st semester	
Classes and lectures:		Workload:		
 Introduction to Programming (lecture, 2 SWS) Lab course Java (lecture, 2 SWS) Lab course Java (exercise, 2 SWS) Java project (programming project, 2 SWS) Workload: 150 Hours private studies 90 Hours in-classroom work 30 Hours work on project 30 Hours exam preparation 		e studies sroom work n project preparation		
 Contents of teaching: Basic concepts of computer science: representation of information and numbers, hardware, software, operating systems, applications Algorithm, Specification, Program Syntax und Semantics of Programming Languages Basic concepts of imperative and OO programming Techniques of secure programming Programming in Java including term-long project Development environment for Java 				
Qualification-goals/Competencies: Students can easily calculate in 2, Students can convert rational and Students can explain the principle Students can independently represent Students can explain the structure Students master the technique of Students can apply basic algorithm Students are basically able to app Students can design, implement a Students can develop and implem Students can implement limited, l	8 and 16 number systems an real numbers into floating p s of text encoding in ASCII, U sent the term 'algorithm' and e and semantics of imperative reading and understanding i mic techniques such as iterati ly safe programming techniq and test simple simple progra- tent solutions satisfying com- but no longer small software	d convert numbers into ea pint numbers and vice vers nicode, and UTF-8. I important properties. programs. mperative algorithms and on and recursion. ues. ms monly accepted quality sta development projects in a	ch other in these systems. a. writing them down for simple problems. ndards team.	
Grading through: written exam successful addressing of the project goals Is requisite for: Lab Course Software Engineering (CS2301-KP06, CS2301) C. freque Engineering (CS2301-KP06, CS2301) 				
 Algorithms and Data Structures (CS1001-KP08, CS1001) 				
Responsible for this module: • Prof. Dr. Stefan Fischer Teacher: • Institute of Telematics • Prof. Dr. Stefan Fischer				



Literature:

- H. P. Gumm and M. Sommer: Einführung in die Informatik Oldenbourg, 10. Auflage, 2012
- G. Goos und W. Zimmermann: Vorlesungen über Informatik (Band 1 und 2) Springer-Verlag, 2006
- D. J. Barnes und M. Kölling: Java lernen mit BlueJ Objects first eine Einführung in Java 6. Auflage, Pearson Studium, 2017
- T. Stark und G. Krüger: Handbuch der Java-Programmierung 5. Auflage, Addison-Wesley, 2007
- R. Sedgewick und K. Wayne: Einführung in die Programmierung mit Java Pearson Studium

Language:

• offered only in German

Notes:

From WS2019 / 20:

Partial Examination CS1000-L1: Introduction to Programming and Programming Course (graded exam, 8 credits) Partial exam CS1000-L2: Java project (ungraded internship, 2 credits)

Prerequisites for attending the module:

- None

Prerequisites for the exam in CS1000-L1:

- Successful completion of homework assignments during the semester.

Prerequisites for the exam in CS1000-L2:

- None



CS1500-KP04, CS1500 - Introduction to Robotics and Automation (ERA)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	Semester each winter semester		4	
 Course of study, specific field and term: Bachelor IT-Security 2016 (optional subject), interdisciplinary, Arbitrary semester Bachelor Biophysics 2024 (compulsory), Elective Computer Science, 5th semester Bachelor Computer Science 2019 (optional subject), Introductory Module Computer Science, 1st semester Bachelor Robotics and Autonomous Systems 2020 (compulsory), Robotics and Autonomous Systems, 1st semester Bachelor Medical Informatics 2019 (optional subject), Introductory Module 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 Biophysics 2016 (compulsory), Elective Computer Science, 5th semester Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 1st semester Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 1st semester Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 1st semester Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 1st semester Bachelor Computer Science 2014 (optional subject), medical computer science, 5th or 6th semester Bachelor Computer Science 2014 (compulsory), specialization field robotics and automation, 1st semester Bachelor CLS 2010 (optional subject), medical engineering science, 5th semester Bachelor Medi S011 (optional subject), medical engineering science, 5th semester Bachelor MES 2011 (optional subject), specialization field robotics and automation, 1st semester Bachelor MES 2011 (optional subject), specialization field robotics and automation, 1st semester 				
Classes and lectures:		Workload:		
Introduction to RoboticsIntroduction to Robotics	and Automation (lecture, 2 SWS) and Automation (exercise, 1 SWS)	 55 Hours private studies 45 Hours in-classroom work 20 Hours exam preparation 		
 Introduction Control systems Programmable Logic Co Combinatorial control Sequential control Feedback control system Plants PID controller Controller parameteriza Autonomous mobile rol Al-paradigms Elementary and emerge Signal acquisition and p Actuators According to the rules or 	ntroller (PLC) ns tion pots nt behaviors rocessing f GSP of the UzL			
 Qualification-goals/Competencies: The students are able to explain the principles of control systems. The students are able to design combinatorial and sequential control systems. The students are able to program simple application problems as PLC-program in the IEC-languages. The students are able to analyze closed-loop controlled systems (plants) and to select and parameterize a suitable feedback PID controller. The students are able to present the principal structure and functionality of autonomous wheel-driven robots. The students are able to program simple autonomous robots in a behavior-based way 				
• written exam				
 Responsible for this module: Prof. DrIng. Mladen Bei Teacher: Institute of Computer Er 	rekovic			



DrIng. Kristian Ehle	rs
Literature:	
• J. L. Jones, D. Roth:	Robot Programming - A Practical Guide to Behavior-Based Robotics - New York: Mc Graw Hill 2004
J. Knespl: Automatis	sierungstechnik 1 - Regelungstechnik - Köln: Stam-Verlag 1999
R. R. Murphy: Introc	uction to Al Robotics - Cambridge, MA: The MIT Press 2000
• G. weilenreutner, D	. Zastrow: Automatisieren mit SPS - Theorie und Praxis - Braunschweig: vieweg 2008
Language:	
 offered only in Gern 	nan
Notes:	
-Computer Science sto written exam at the e	udents are issued a B certificate, after having finished entire assignments including the tests and having passed the nd of the term.
Students of other maj	ors are issued an A-certificate after having passed the written exam.
Prerequisites for atter	ding the module:
- None	
Prerequisites for the e	vam.
- Successful completic	n of homework assignments during the semester.
Written exam:	
-CS1500-L1: Introduct	ion to Robotics and Automation, written exam, 60 - 120 min, 100% modul grade.



MA1000-KP08, MA1000 - Linear Algebra and Discrete Structures 1 (LADS1)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each winter semester		8	
1 Semester each winter semester 8 Course of study, specific field and term: • • Minor in Teaching Mathematics, Bachelor of Arts 2023 (compulsory), mathematics, 3rd semester • • Bachelor CLS 2023 (compulsory), mathematics, 1st semester • • Bachelor Biophysics 2024 (compulsory), mathematics, 1st semester • • Bachelor MES 2020 (compulsory), mathematics, 1st semester • • Bachelor Media Informatics 2020 (compulsory: aptitude test), mathematics, 1st semester • • Bachelor Robotics and Autonomous Systems 2020 (compulsory: aptitude test), mathematics, 1st semester • • Bachelor Robotics and Autonomous Systems 2020 (compulsory), mathematics, 1st semester • • Minor in Teaching Mathematics, Bachelor of Arts 2017 (compulsory), mathematics, 1st semester • • Bachelor CLS 2016 (compulsory: aptitude test), mathematics, 1st semester • • Bachelor CLS 2016 (compulsory), mathematics, 1st semester • • Bachelor CLS 2016 (compulsory), mathematics, 1st semester • • Bachelor Robotics and Autonomous Systems 2016 (compulsory: aptitude test), mathematics, 1st semester • • Bachelor CLS 2016 (compulsory), mathematics, 1st semester • • Bachelor Robotics and Autonomous Systems 2016 (compulsory: aptitude test), mathematics, 1st semester •				
Classes and lectures: • Linear Algebra and Discrete Structur • Linear Algebra and Discrete Structur	Classes and lectures: Workload: • Linear Algebra and Discrete Structures 1 (lecture, 4 SWS) • 125 Hours private studies and exercises • Linear Algebra and Discrete Structures 1 (exercise, 2 SWS) • 90 Hours in-classroom work • 25 Hours exam preparation			
 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 fundamental concepts of linear algebra. They understand basic thought processes and methods of proof. They can explain fundamental relationships in linear algebra. They can apply fundamental concepts and methods of proof to algebraic problems. They have an understanding of abstract thought processes. Interdisciplinary qualifications: Students have basic competency in modelling. They can transfer fundamental theoretical concepts to similar applications. They can work on elementary mathematics problems within a team. They can present elementary solutions to their problems to a group. 				
Grading through: • 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



MA2000-KP08, MA2000 - Analysis 1 (Ana1KP08)				
Duration: Turnus of offer: Credit points:				
1 Semester ea	Semester each winter semester 8			
Course of study, specific field and term: Bachelor CLS 2023 (compulsory), mathematics, 1st semester Minor in Teaching Mathematics, Bachelor of Arts 2023 (compulsory), mathematics, 5th semester Bachelor Biophysics 2024 (compulsory: aptitude test), mathematics, 1st semester Bachelor MES 2020 (compulsory: aptitude test), mathematics, 1st semester Bachelor Media Informatics 2020 (compulsory: aptitude test), mathematics, 1st semester Bachelor Media Informatics 2020 (compulsory: aptitude test), mathematics, 1st semester Bachelor Robotics and Autonomous Systems 2020 (compulsory: aptitude test), mathematics, 1st semester Bachelor Computer Science 2019 (compulsory), mathematics, 1st semester Bachelor Computer Science 2019 (compulsory), mathematics, 1st semester Bachelor Computer Science 2016 (compulsory), mathematics, 1st semester Bachelor Robotics and Autonomous Systems 2016 (compulsory: aptitude test), mathematics, 1st semester Bachelor Robotics and Autonomous Systems 2016 (compulsory: aptitude test), mathematics, 1st semester Bachelor Robotics and Autonomous Systems 2016 (compulsory: aptitude test), mathematics, 1st semester Bachelor IT-Security 2016 (compulsory), mathematics, 1st semester Bachelor Medical Informatics 2014 (compulsory), mathematics, 1st semester Bachelor Media Informatics 2014 (compulsory), mathematics, 1st semester Bachelor Computer Science 2014 (compulsory), mathematics, 1st semester Bachelor Computer Science 2011 (compulsory), mathematics, 1st semester Bachelor Medical Informatics 2011 (compulsory), mathematics, 1st semester Bachelor Medical Inf				
Classes and lectures: • Analysis 1 (lecture, 4 SWS) • Analysis 1 (exercise, 2 SWS)	 Bachelor Computer Science 2012 (Compulsory), mathematics, sid semester Classes and lectures: Analysis 1 (lecture, 4 SWS) Analysis 1 (exercise, 2 SWS) Workload: 90 Hours in-classroom work 			
Contents of teaching:				
Contents of teaching: Sequences and series Functions and continuity Differentiability, Taylor series Metric and normalized spaces, basic topological concepts Multivariate differential calculus 				
 Qualification-goals/Competencies: Students understand the basic terms of Students understand the basic thoughts technically motivated problems. 	analysis, especially the con s and proof techniques and	ncept of convergence. d are able to use them for the analytical treatment of scientifially or		
 Students can explain basic relationships in real analysis. Students can apply the basic concepts and proof techniques of differential calculus. Students have an understanding for abstract structures. Interdisciplinary qualifications: Students have a basic competence in modeling. Students can transfer theoretical concepts to similar applications. Students can work as a group on elementary mathematical problems. 				
Grading through:				
• written exam				
Is requisite for: • Analysis 2 (MA2500-KP09) • Analysis 2 (MA2500-KP08)				



 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





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RO1500-KP08 - Technical Mechanics (TechMec)					
Duration:	Turnus of offer:	Credit points:			
2 Semester	starts every summer semes	ter 8			
Course of study, specific field • Bachelor Robotics and A • Bachelor Robotics and A Classes and lectures: • Engineering Mechanics • Engineering Mechanics • Engineering Mechanics • Engineering Mechanics • Engineering Mechanics	and term: utonomous Systems 2020 (compulsory), utonomous Systems 2016 (compulsory), 2 (lecture, 2 SWS) 2 (exercise, 2 SWS) 1 (lecture, 2 SWS) 1 (exercise, 2 SWS)	Robotics and Autonomous Systems, 2nd and 3rd semester Robotics and Autonomous Systems, 2nd and 3rd semester Workload: • 120 Hours in-classroom work • 120 Hours private studies and exercises			
Contents of teaching: Statics and Elastostatics Systems and equilibria of Gravitational force and of Planar systems of forces Bearings and support of Trusses Principle of virtual displation Law of elasticity Beam theory Stability of elastic system Energy conservation and Torsion Kinematics of point masses Kinetics of rigid bodies Linearization Vibration theory Product development and Requirements and targe Methods of verification	of forces and moments center of mass multibody systems acements d approximate methods ses es es nd construction process t specification solutions, selection and evaluation and fault prevention				
Qualification-goals/Competer Students can explain the They can calculate static They can develop produ They are able to model of 	ncies: e structure and basic properties of static r e mechanical systems. Incts methodically and possess the necessa dynamic mechanical systems using kineti	nechanical systems. ary knowledge and skills. cs and kinematic relations.			
Grading through: written examination 					
Responsible for this module: • Prof. Dr. Georg Schildbac Teacher: • Institute for Electrical En • Prof. DrIng. Christian H • Prof. Dr. Georg Schildbac	ch gineering in Medicine erzog ch				
Literature: • Dankert, Jürgen; Danker	t, Helga: Technische Mechanik. Statik, Fes	tigkeitslehre, Kinematik/Kinetik - 7. Aufl. Wiesbaden: Springer Vieweg			



2013

- Gross, Dietmar; Hauger, Werner; Schröder, Jörg; Wall, Wolfgang A.: Technische Mechanik 1. Statik With assistance of Dietmar Gross. 12., aktualisierte. Aufl. Berlin [u.a.]: Springer Vieweg (Springer-Lehrbuch) 2013
- Gross, Dietmar; Hauger, Werner; Schröder, Jörg; Wall, Wolfgang A.: Technische Mechanik 2. Elastostatik [Verschiedene Aufl.]. Berlin: Springer Vieweg (Springer-Lehrbuch) 2014
- Gross, Dietmar; Hauger, Werner; Schröder, Jörg; Wall, Wolfgang A.: Technische Mechanik 3. Kinetik 13., überarb. Aufl. Berlin, Heidelberg: Springer Berlin Heidelberg (Springer-Lehrbuch) 2015
- Pahl, Gerhard; Beitz, Wolfgang; Feldhusen, Jörg; Grote, Karl-H: Konstruktionslehre. Grundlagen erfolgreicher Produktentwicklung Methoden und Anwendung 6. Aufl. Berlin, Heidelberg: Springer-Verlag Berlin Heidelberg 2005

Language:

• offered only in German

Notes:

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

- Successful completion and submission of exercises as specified at the beginning of the semester.

Module Exam(s):

- RO1500-L1: Technical Mechanics, written exam, 90min, 100% of the module grade





CS1001-KP08, CS1001 - Algorithms and Data Structures (AuD)				
Duration:	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 / electrical engineering, 3rd semester at the earliest 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 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 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 MES 2014 (optional subject), computer science / electrical engineering, 4th or 6th semester Bachelor Medical Informatics 2014 (compulsory: aptitude test), foundations of computer science, 2nd semester Bachelor Medical Informatics 2014 (compulsory: aptitude test), foundations of computer science, 2nd semester Bachelor Medical Informatics 2011 (compulsory: aptitude test), foundations of computer science, 2nd semester Bachelor Medical Informatics 2011 (compulsory: aptitude test), foundations of computer science, 2nd semester Bachelor MES 2011 (compulsory), computer science, 2nd semester Bachelor Medical Informatics 2011 (compulsory), computer science, 2nd semester Bachelor LLS 2010 (compulsory), foundations of co				
Classes and lectures:		Workload:		
 Algorithms and Data Structures (level of the second seco	 Algorithms and Data Structures (lecture, 4 SWS) Algorithms and Data Structures (exercise, 2 SWS) Algorithms and Data Structures (exercise, 2 SWS) Structures (exercise, 2 SWS) St			
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, g Optimization problems, sequence a determining change coins, notion of String matching Hard problems Pruning and subgraph isomorphism Approximation 	reedy algorithms alignment (longest common of completeness of algorithm n	subsequence), knapsack p is	problem, planning and layout problems,	
 Qualification-goals/Competencies: The students can explain the central application scenarios for all the iteration 	al ideas, define the relevant on site of teach and the second states and the second states of teach and the second states and the second states and the second states are states and the second states are states and the second states are states are states and the second states are states ar	concepts and explain the f ning.	unctioning of algorithms with help of	
Grading through: • written exam				
Is requisite for: • Databases (CS2700-KP04, CS2700) • Lab Course Software Engineering (CS2301-KP06, CS2301)			



 Software Engineering (CS2300-KP06, CS2300SJ14) Theoretical Computer Science (CS2000-KP08, CS2000) Algorithm Design (CS3000-KP04, CS3000)
Requires:
 Introduction to Programming (CS1000-KP08, CS1000SJ14-MML/MI, CS1000SJ14-MIW) Introduction to Programming (CS1000-KP10, CS1000SJ14)
Responsible for this module:
Prof. DrIng. Thomas Eisenbarth
Teacher:
Institute for IT Security
Prof. Dr. rer. nat. Esfandiar Mohammadi
Literature:
• Thomas H. Cormen, Charles E. Leiserson, Ronald Rivest, Clifford Stein: Algorithmen - Eine Einführung - Oldenbourg Verlag, 2013
Language:
offered only in German
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):
- Successful completion of exercise sheets as specified at the beginning of the semester.
Module exam(s):
- CS1001-L1: Algorithms and Data Structures, written exam, 90min, 100% of the module grade.



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СS1200-КР06, СS	200SJ14 - Fundame	ntals of Computer E	ngineering 1 (TGI1)
Duration:	Turnus of offer:		Credit points:
1 Semester	each summer semester		6
Course of study, specific field and term: Bachelor MES 2020 (compulsory), cor Bachelor Media Informatics 2020 (cor Bachelor Computer Science 2019 (co Bachelor Robotics and Autonomous S Bachelor Medical Informatics 2019 (o Bachelor Computer Science 2016 (co Bachelor Computer Science 2016 (co Bachelor Robotics and Autonomous S Bachelor IT-Security 2016 (compulsor Bachelor Biophysics 2016 (optional su Bachelor Medical Informatics 2014 (co Bachelor Media Informatics 2014 (cor Bachelor MES 2014 (compulsory), fou Bachelor Computer Science 2014 (co Bachelor Biophysics 2024 (optional su	nputer science, 4th semes npulsory), computer scien mpulsory), foundations of Systems 2020 (compulsor ptional subject), compute mpulsory), foundations of Systems 2016 (compulsory y), computer science, 2nd ubject), computer science, ompulsory), computer scien ndations of computer scien mpulsory), foundations of ubject), computer science,	ter ice, 2nd semester computer science, 2nd se y: aptitude test), computer r science, 4th to 6th semes computer science, 2nd se y: aptitude test), computer semester 6th semester ence, 2nd semester ence, 2nd semester ence, 4th semester computer science, 2nd se 6th semester	emester r science, 2nd semester ster emester r science, 2nd semester
Classes and lectures:		Workload:	
 Fundamentals of Computer Engineer Fundamentals of Computer Engineer 	 Classes and lectures: Fundamentals of Computer Engineering 1 (lecture, 2 SWS) Fundamentals of Computer Engineering 1 (exercise, 2 SWS) Fundamentals of Computer Engineering 1 (exercise, 2 SWS) 60 Hours in-classroom work 20 Hours exam preparation 		
 Technological realization Combinatorial and sequential circuits Memories Microprocessors Assembler programming Microcontrollers Input/Output programming Basic processor architectures 			
Qualification-goals/Competencies:			
 The students can explain the principal principle. They can elucidate the principal function algebra. They can demonstrate the basic circule. They can explain the structure and one of the principal function set of the principal function. They can elucidate the instruction set of the principal function. They can program microcontrollers for the principal function. They can discuss and compare basic 	al organization of a compu- tioning of combinatorial a nits for the technological re- peration of registers and r t of a microprocessor exer tellen eines Mikrocontrolle or simple applications in a processor architectures ar	uter and the execution of a and sequential circuits and ealization of logic gates w nemories. nplarily and to be able to ers beschreiben und in Ass ssembly language. ad their instruction sets.	a program according to the Von-Neumann d describe them formally using switching rith bipolar and MOS transistors. use it for assembly programming. semblersprache programmieren (mit Polling
Grading through:			
• written exam			
Is requisite for: • Embedded Systems (CS2101-KP04, C • Computer Architecture (CS2100-KP04 • Fundamentals of Computer Engineer	52101) 4, CS2100SJ14) ing 2 (CS1202-KP06, CS12	02)	



Responsible for this module:
Prof. DrIng. Mladen Berekovic
Teacher:
Institute of Computer Engineering
DrIng. Kristian Ehlers
Literature:
• C. Hamacher, Z. Vranesic, S. Zaky, N. Manjikian: Computer Organisation and Embedded Systems - McGraw-Hill 2012
 M. M. Mano, C. K. Kime: Logic and Computer Design Fundamentals - Pearson 2007 D. A. Batterran, J. L. Hannessin Computer Organization & Design The Hardware (Software Interface). Margan Keyfmann 2011
 T. Ungerer, U. Brinkschulte: Mikrocontroller und Mikroprozessoren - Springer 2010
Language:
offered only in German
Notes:
Admission requirements for taking the module:
- None
Admission requirements for participation in module examination(s):
- Successful completion of practical exercises as specified at the beginning of the semester.
Module examination(s):
- CS1200-L1: Technical Foundations of Computer Science 1, written exam 120min, 100% of 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 Biophysics 2024 (compulsory), mathematics, 2nd semester • Bachelor Gomputer Science 2019 (compulsory: aptitude test), mathematics, 2nd semester • Bachelor Robotics and Autonomous Systems 2020 (compulsory), mathematics, 2nd semester • Bachelor Medical Informatics 2019 (compulsory: aptitude test), mathematics, 2nd semester • Minor in Teaching Mathematics, Bachelor of Arts 2017 (compulsory), mathematics, 4th semester • Bachelor Computer Science 2016 (compulsory: aptitude test), mathematics, 2nd semester • Bachelor Robotics and Autonomous Systems 2016 (compulsory), mathematics, 2nd semester • Bachelor Computer Science 2016 (compulsory: aptitude test), mathematics, 2nd semester • Bachelor Computer Science 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 Biophysics 2016 (compulsory), mathematics, 2nd semester • Bachelor Robotics and Autonomous Systems 2016 (compulsory), mathematics, 2nd semester • Bachelor Biophysics 2016 (compulsory), mathematics, 2nd semester • Bachelor Robotics and Autonomous Systems 2016 (compulsory), mathematics, 2nd semester • Bachelor Medi				
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, m Determinants Linear mappings Orthogonality Eigenvalues Qualification-goals/Competencies: The students understand advard They understand advanced the They can apply advanced come They can explain advanced rel Interdisciplinary qualifications Students can transfer advanced They have an advanced comp They can solve complex proble They can present the solution	atrices inced concepts of linear algebra. ought processes and methods of cepts and methods of proof to alg ationships in linear algebra. : d theoretical concepts to similar etency in modeling. ems within a group. to complex problems to a group.	proof. gebraic problems. applications.		
Grading through: • written exam				
Is requisite for: Image Registration (MA5030-K Image Registration (MA5030-K Mathematical Methods of Imag Mathematical Methods in Imag Optimization (Advanced Math	P05) P04, MA5030) ge Processing (MA4500-KP05) ge Processing (MA4500-KP04, MA ematics) (MA4031-KP08)	4500)		



 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



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) 	Classes and lectures: Workload: • Analysis 2 (lecture, 2 SWS) • 60 Hours private studies • Analysis 2 (exercise, 1 SWS) • 45 Hours in-classroom work • 15 Hours exam preparation			
 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



CS1202-KP06, CS1202 - Fundamentals of Computer Engineering 2 (TGI2)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each winter semester		6	
Course of study, specific field and term: Bachelor MES 2020 (compulsory), con Bachelor Media Informatics 2020 (op Bachelor Computer Science 2019 (co Bachelor Robotics and Autonomous Bachelor Medical Informatics 2019 (co Bachelor Computer Science 2016 (co Bachelor Computer Science 2016 (co Bachelor Robotics and Autonomous Bachelor Medical Informatics 2014 (co Bachelor Media Informatics 2014 (op Bachelor MES 2014 (compulsory), fou Bachelor Computer Science 2014 (co Bachelor IT-Security 2016 (optional s	nputer science, 5th semest tional subject), computer s mpulsory), foundations of Systems 2020 (compulsory ptional subject), computer mpulsory), foundations of Systems 2016 (compulsory ptional subject), computer s indations of computer scie mpulsory), foundations of ubject), specific, Arbitrary s	er cience, 5th or 6th semester computer science, 3rd sem r), computer science, 3rd se science, 4th to 6th semest computer science, 3rd sem), computer science, 3rd se science, 5th or 6th semester cience, 5th or 6th semester nce, 5th semester computer science, 3rd sem emester	ester emester er ester mester er r ester	
Classes and lectures:		Workload:		
 Fundamentals of Computer Enginee Fundamentals of Computer Enginee 	 Fundamentals of Computer Engineering 2 (lecture, 2 SWS) Fundamentals of Computer Engineering 2 (exercise, 2 SWS) 			
 Design of combinatorial circuits Design of sequential circuits Hardware description languages Register-transfer languages Data paths Control units Microprogramming CPUs Semiconductor components and circo Integrated circuits Programmable logic (CPLDs, FPGAs) CAD-tools for circuit design 	uit families			
Qualification-goals/Competencies: • The students can formally describe a • They can use hardware description la • They can formally describe and desig • They can exploit microprogramming • They can design simple processors (o • They can elucidate and judge the mo • They can describe and judge integra • They can use CAD-tools to design, to	nd design combinatorial an anguages, particularly VHD on sequential circuits with o for the realization of contr CPUs). ost important technologies ted circuits, in particular pr o simulate and to implemer	nd sequential circuits on ga L, for the modelling of simp control unit and data path ol units. for the realization of simpl ogrammable logic like FPG nt digital circuits on FPGAs.	ate level. ple circuits. on register-transfer level. le digital circuits (bipolar, MOS, CMOS). ¡As.	
Grading through: • written exam				
Is requisite for: • Computer-Aided Design of Digital Ci	rcuits (CS3110-KP04, CS311	0)		
Requires: • Fundamentals of Computer Engineer	ing 1 (CS1200-KP06, CS120)0SJ14)		
Responsible for this module:				



Prof. DrIng. Mladen Berekovic
Teacher:
Institute of Computer Engineering
DrIng. Kristian Ehlers
Prof. DrIng. Mladen Berekovic
Literature:
 T.L. Floyd: Digital Fundamentals - A Systems Approach - Pearson 2012
M. M. Mano, C. R. Kime: Logic and Computer Design Fundamentals - Pearson 2007
C. H. Roth, L.L. Kinney: Fundamentals of Logic Design - Cengage Learning 2009
Language:
offered only in German
Notes:
Prerequisites for attending the module:
- None
Prerequisites for the exam:
- Successful completion of homework assignments during the semester
- continuous, successful participation in practical course



CS2300-KP06, CS2300SJ14 - Software Engineering (SWEng14)				
Duration:	Turnus of offer:	Credit points:	Max. group size:	
1 Semester	each winter semester	6	12	
Course of study, specific field • Bachelor Biophysics 20	 Course of study, specific field and term: Bachelor Biophysics 2024 (optional subject), computer science, 5th semester 			
 Bachelor Media informa Bachelor Computer Sci Bachelor Robotics and Bachelor Medical Informa 	ence 2019 (compulsory), computer science ence 2019 (compulsory), foundations of Autonomous Systems 2020 (compulsory matics 2019 (compulsory), computer scie	computer science, 3rd seme), computer science, 3rd seme nce, 3rd semester	ster nester	
 Bachelor Robotics and Bachelor IT-Security 20 Bachelor Biophysics 20 	 Bachelor Robotics and Autonomous Systems 2016 (compulsory), computer science, 3rd semester Bachelor IT-Security 2016 (compulsory), computer science, 3rd semester Bachelor Biophysics 2016 (optional subject), computer science, 5th semester 			
 Bachelor Computer Sci Bachelor Media Inform Bachelor Medical Inform Bachelor Computer Sci 	atics 2016 (compulsory), foundations of a atics 2014 (compulsory), foundations of c matics 2014 (compulsory), computer scie ence 2014 (compulsory), foundations of a	computer science, 3rd seme computer science, 3rd seme nce, 3rd semester computer science, 3rd seme	ster ster	
Classes and lectures:		Workload:		
 Software Engineering (Software Engineering ((lecture, 3 SWS) (exercise, 1 SWS)	 100 Hours private 60 Hours in-classro 20 Hours exam pro 	studies and exercises oom work eparation	
Contents of teaching:				
 overview on major field Software development Project plan and workle Software management System Analysis and re Basics of UML Software architectures Validation and verificat Legal aspects: copyrigh 	ds of software engineering c, software process models oad estimation c and quality assurance equirements analysis and design patterns tion nt, standards, liability, licenses			
Qualification-goals/Competencies				
 The students understate They can argue about the students and the students understate They can explain import of the state They can describe and They are able to model They can apply the base They are able to apply They can discuss about 	nd software design as an engineering pro major software process models. rtant techniques and factors of software evaluate measures for quality ensurance l software systemson different levels of a sic concepts of object-oriented modelling design patterns in a useful way. t legal aspects of software development.	ocess. management. btraction. J and design.		
Grading through:				
Written or oral exam as announced by the examiner				
Is requisite for:				
 Safe Software (CS3250-KP08) Lab Course Software Engineering (CS2301-KP06, CS2301) 				
Requires:				
 Algorithms and Data St Introduction to Program 	tructures (CS1001-KP08, CS1001) mming (CS1000-KP10, CS1000SJ14)			
Responsible for this module: • Prof. Dr. Martin Leucker	r			



Teacher:

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

Literature:

- H. Balzert: Lehrbuch der Software-Technik: Software-Entwicklung Spektrum Akademischer Verlag 2001
- B. Brügge, A. H. Dutoit: Objektorientierte Softwaretechnik mit UML, Entwurfsmustern und Java Pearson Studium 2004
- I. Sommerville: Software Engineering Addison-Wesley 2006
- B. Oestereich: Analyse und Design mit der UML 2.1 Objektorientierte Softwareentwicklung Oldenbourg 2006
- D. Bjorner: Software Engineering 1-3 Springer 2006

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.

Module exam(s):

- CS2300-L1: Software Engineering, written exam, 90min, 100% of the module grade.

Passing this module is a formal requirement for participation in the module CS2301-KP06 Lab Course Software Engineering. It is recommended to do the internship directly in the following 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), mobics and Autonomous Systems, 5th or 6th semester Bachelor Medical Informatics 2019 (optional subject), medical computer science, 4th to 6th 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 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 Medical Informatics 2011 (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 Informatic			
Classes and lectures:		Workload:	
 Robotics (lecture, 2 SWS) Robotics Exercise (exercise, 2 SWS)		60 Hours in-classr60 Hours privates	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 Requires: • Analysis 1 (MA2000-KP08, MA2000) • Linear Algebra and Discrete Structur Responsible for this module:	n (CS3501-KP04, CS3501) es 1 (MA1000-KP08, MA100	0)	



• 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

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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)



ME2400-KP08, ME2400 - Fundamentals of Electrical Engineering 1 (ETechnik1)			
Duration:	Turnus of offer:		Credit points:
1 Semester	each winter semester 8		8
Course of study, specific field and term: Bachelor Computer Science 2019 (op Bachelor MES 2020 (compulsory), ele Bachelor Robotics and Autonomous Bachelor MES 2011 (optional subject Bachelor Computer Science 2016 (op Bachelor Robotics and Autonomous Bachelor MES 2014 (compulsory), ele Bachelor IT-Security 2016 (optional s	otional subject), Extended o ectrical engineering, 3rd set Systems 2020 (compulsor), electrical engineering, 4t otional subject), advanced o Systems 2016 (compulsory ectrical engineering, 3rd set ubject), specific, Arbitrary s	optional subjects, Arbitrary mester y), electrical engineering, 3 h to 6th semester curriculum, Arbitrary semes), Robotics and Autonomo mester semester	semester rd semester ster us Systems, 3rd semester
Classes and lectures:		Workload:	
 Fundamentals of Electrical Engineeri Fundamentals of Electrical Engineeri 	 Fundamentals of Electrical Engineering 1 (lecture, 4 SWS) Fundamentals of Electrical Engineering 1 (exercise, 2 SWS) 		
Contents of teaching: Maxwell s Equations and electrical of Circuit Abstraction Passive electrical circuit elements Methods of linear and nonlinear circo Measuring voltages and currents Equivalent circuit diagram (ideal/non MOSFET Switch Digital Abstraction MOSFET Amplifier	ircuits uit analysis nideal sources, MOSFETs, B	JTs)	
 Qualification-goals/Competencies: Students understand how electrical process. Students can calculate and analyze e Students understand how complicat circuit diagrams with sources and pa Students know and comprehend the know how to describe and analyze if Students know the difference betwee Grading through: written exam 	circuits are derived from M electrical circuits with passi red circuits, e.g. with MOSF issive elements. e basic physical structure an ts operation. en large and small signal a	axwell s equations and wh ve elements. ETs and BJTs can be expres nd operation of a MOSFET o nalysis and are able to use	nich simplifications are accepted in this ased and analyzed by means of equivalent device as a switch and as an amplifier and this to analyze electrical circuits.
Is requisite for: • Fundamentals of Electrical Engineering 2 (ME2700-KP08, ME2700)			
Requires: • Analysis 2 (MA2500-KP04, MA2500) • Analysis 1 (MA2000-KP08, MA2000) • Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500) • Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000)			
Responsible for this module: • Prof. Dr. Philipp Rostalski Teacher: • Institute for Electrical Engineering in Medicine			



• Prof. Dr. Philipp Rostalski

Literature:

- Argawal, Lang: Foundations of Analog and Digital Circuits Elsevier; ISBN: 1-55860-735-8
- M. Albach: Elektrotechnik ISBN: 978-3-8689-4081-7

Language:

offered only in German

Notes:

In the Bachelor of Computer Science CS3120-KP04 Electronics and Microsystems Engineering and ME2400-KP08 Fundamentals of Electrical Engineering 1

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cannot be chosen in combination due to content overlap.

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

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

Module Exam(s):

- ME2400-L1: Fundamentals of Electrical Engineering 1, written exam, 90min, 100% of module grade.



PS4640-KP04 - Technikethik (TE)			
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	y), interdisciplinary compet	tence, 3rd semester
Classes and lectures:		Workload:	
 Ethics of Technology (lecture, 2 SWS) Ethics of Technology (seminar, 1 SW) 	Ethics of Technology (lecture, 2 SWS) Ethics of Technology (seminar, 1 SWS) Subscription Su		
Contents of teaching:			
 Fundamental ethical theories and methods Responsible Research & Innovation Trustworthiness of technologies Aspects of privacy Justice and Eco-social Inequality transparency, technological opacity, interpretability and explainability Ironies of automation Approaches to ethical decision-making Autonomous systems in the context of societal transformation Novel and unsolved cases in ethical discourse on the basis of modern and innovative technologies 			
 The students know ethical and socie The students are able to evaluate an The students are able to decide in ca The students are able to present pre The students know fundamental future artificial intelligence. The students are able to comprehen Students are able to systematically comprehen 	etal challenges of innovative ad analyze future and existin ase studies on the basis of o ecise ethical arguments to d ure ethical debates with req asibly express their findings develop solution proposals	e technologies and are able ng technologies with regar different normative ethical lefend their opinions in dis gard to automation and th in interdisciplinary exchan based on ethical criteria ar	e to articulate these precisely. rd to associated ethical debates. theories. course. e development of autonomous systems and nge. nd present them with arguments.
Grading through: • portfolio exam			
Responsible for this module: • Prof. DrIng. Christian Herzog Teacher: • Institute for Electrical Engineering in Medicine • Prof. DrIng. Christian Herzog			
Literature: • van de Poel, Ibo; Royakkers, Lambèr: Ethics, Technology, and Engineering - An Introduction - Wiley-Blackwell • :			
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):

- Submissions in groups will be required periodically during the semester, accounting for 20% of the final grade.

- At the end of the semester a report (80%) is required, whereby the respective individual performance must be identified and will be evaluated separately.

- The grade of the report is calculated from: 70% individual performance + 30% overall grade of the report (= average grade of the individual performances of the report).



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CS2251-KP04 - Cybersecurity Internship (CyberSecPr)			
Duration:	Turnus of offer:	Credit points:	
1 Semester	each summer semester	4 (Тур В)	
Course of study, specific • Bachelor Robotics • Bachelor Robotics • Bachelor Compute • Bachelor Medical I	field and term: and Autonomous Systems 2016 (optional s and Autonomous Systems 2020 (optional rr Science 2019 (optional subject), Extended nformatics 2019 (optional subject), compu	subject), Additionally recognized elective module, 4th or 6th semester subject), Additionally recognized elective module, 4th or 6th semester d optional subjects, 4th semester ter science, 4th to 6th semester	
Classes and lectures: • Practical Course C	Classes and lectures: Workload: • Practical Course Cybersecurity (practical course, 3 SWS) • 50 Hours work on project • 40 Hours in-classroom work • 30 Hours group work		
Contents of teaching: Practical exploitati Conduct of risk an Analysis of security Design, realization Discussion about a Getting acquainte	on of security vulnerabilities in various fiel alyses and implementation of defensive m y requirements in a complex use case , and analysis of a state-of-the-art security attacker motivation, protective measures, a d with penetration testing tools	ds of application easures solution nd impact of attacks	
Qualification-goals/Com • Students can expla • They can independ • They are able to ic	petencies: ain the basic methods in the field of cybers dently perform security analyses for simple lentify weak points and develop concrete s	ecurity and apply them to case studies. scenarios. solutions to eliminate them.	
Grading through: • continuous, succes • project work	ssful participation in practical course		
Responsible for this more • Prof. DrIng. Thom Teacher: • Institute for IT Sect • DrIng. Jan Wichel	dule: nas Eisenbarth urity Imann		
Literature: D. Gollmann: Com R. Anderson: Secu C. Kaufman, R. Per 2002 W. Du: W. Du: Con	puter Security, Third Edition, Wiley, 2011 - rity Engineering - Second Edition, Wiley, 20 Iman, and M. Speciner: Network security: p nputer Security: A Hands-on Approach - Fir	Third Edition, Wiley, 2011 108 rivate communication in a public world - Second Edition, Prentice Hall, st Edition, CreateSpace Independent Publishing Platform, 2017	
Language: • offered only in Gei	• offered only in German		
Notes:			



Admission requirements for taking the module: - None

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

Module Exam(s):

- CS2251-L1 Practical Cybersecurity, ungraded practical, 100% of (non-existent) module grade.

The course is limited to 60 places; compulsory participants will be given priority; allocation of further places according to registration order in Moodle;

Participation is only possible if CS2250-KP04 Cybersecurity is taken in parallel or has already been taken. Parallel enrollment is recommended.

The courses of this module are also part of CS2250-KP08.

(Share of Institute for IT Security in P is 100%)





CS2110-KP04, CS2110 - Mobile Robots (MobilRob14)			
Duration:	Turnus of offer:	Credit points:	
1 Semester	each summer semester 4		
Course of study, specific field and term: Bachelor Robotics and Autonomous Bachelor Computer Science 2019 (op Bachelor Media Informatics 2020 (op Bachelor Computer Science 2016 (op Bachelor Robotics and Autonomous Bachelor Computer Science 2014 (co Bachelor IT-Security 2016 (optional sector)	Systems 2020 (compulsory), Robotic otional subject), major subject inform otional subject), Robotics and Autono otional subject), major subject inform Systems 2016 (compulsory), Robotics ompulsory), specialization field roboti subject), specific, Arbitrary semester	es and Autonomous Systems, 4th semester latics, Arbitrary semester mous Systems, 5th or 6th semester latics, Arbitrary semester s and Autonomous Systems, 4th semester cs and automation, 5th semester	
Classes and lectures:	Worklo	bad:	
 Mobile Robots (lecture, 2 SWS) Mobile Robots (exercise, 1 SWS) 	 Mobile Robots (lecture, 2 SWS) Mobile Robots (exercise, 1 SWS) Mobile Robots (exercise, 1 SWS) 20 Hours exam preparation 		
Contents of teaching:			
 Reactive behaviour Sensors Actuators, kinematics of the drives Hybrid deliberative/reactive behaviour Strategies of actions maps, self-localization Routing and navigation Robot learning Multi-robots Human-robot interaction Currentds trends, sample robots 			
 Qualification-goals/Competencies: The students are able to describe and classify the various AI paradigms for mobile robots (reactive, deliberative, hybrid). They are able to explain and evaluate the most important sensors and actuators for mobile robots. They are able to describe and apply the basic methods of self-localization, planning and navigation in mobile robotics. They are able to iscuss the basic approaches for robot learning as well as multi-robot and human-robot interaction. They are able to elucidate the state of the art and current trends in mobile robotics by sample robots. They are able to design and program mobile robots. 			
Grading through:Written or oral exam as announced by the examiner			
Responsible for this module: • Prof. DrIng. Mladen Berekovic Teacher: • Institute of Computer Engineering • Dr. rer. nat. Javad Ghofrani			
Literature:			
 J. Hertzberg, K. Lingemann, A. Nüchter: Mobile Roboter - Springer Vieweg 2012 R. R. Murphy: Introduction to AI Robotics - Cambridge, MA: The MIT Press 2000 R. Siegwart, I. R. Nourbakhsh: Introduction to Autonomous Mobile Robots - Cambridge, MA: The MIT Press 2011 			
Language: • offered only in German			



Notes:

Prerequisites for attending the module: - None

Prerequisites for the exam:

- continuous, successful participation in practical course


CS2150-	KP08, CS2150SJ14 - Operatir	ig Systems and Netwo	orks (BSNetze14)	
Duration:	Turnus of offer: Credit points:			
1 Semester	emester each summer semester 8			
Course of study, specific field an Bachelor Media Informatics Bachelor Computer Science Bachelor Robotics and Aut Bachelor Medical Informatic Bachelor Computer Science Bachelor Robotics and Aut Bachelor IT-Security 2016 (Bachelor Media Informatics Bachelor Medical Informatics Bachelor Computer Science	ad term: s 2020 (compulsory), computer scien e 2019 (compulsory), foundations of onomous Systems 2020 (compulsory) ics 2019 (compulsory), computer scie e 2016 (compulsory), foundations of onomous Systems 2016 (compulsory compulsory), computer science, 4th s 2014 (compulsory), foundations of ics 2014 (compulsory), computer scie e 2014 (compulsory), foundations of	ce, 4th semester computer science, 4th sem /), computer science, 4th se nce, 4th semester computer science, 4th sem), computer science, 4th seme semester computer science, 4th seme nce, 4th semester computer science, 4th seme	ester emester ester mester ester ester	
Classes and lectures:		Workload:		
 Operating Systems and Ne Operating Systems and Ne	 Operating Systems and Networks (lecture, 4 SWS) Operating Systems and Networks (exercise, 2 SWS) Operating Systems and Networks (exercise, 2 SWS) Hours in-classroom work 20 Hours exam preparation 			
Contents of teaching:		·		
 Coding of Symbols and Nu Foundations of Operating Processes, Inter-Process Co Storage Management Input / Output Files and File Systems Examples (UNIX, Windows, Computer Networks and the Application Layer Transport Layer Network Layer Link and Physical Layer 	Imbers Systems ommunication and Process Manager mobile OS) ne Internet	ient		
 Qualification-goals/Competenci Students know about the n Students are able to judge Students are able to apply At the end of the course, s Students know the import and services of each layer The students are able deci The students know how the Students can apply the model 	es: main concepts of operating systems. , which OS concepts can be appropri the most important strategies and a tudents know the most important co ance of the different layers of the OS de which network technologies to us the Internet works and are able to pro- ost important methods and algorithm	ately applied to novel com Igorithms for operating sys incepts ofcomputer networ I andInternet protocol suite se to meetthe requirements gram smallapplications as from thefield of networks	puting architectures. tems. rks a along with the most important protocols s of any given application scenario s	
Grading through: • written exam				
Responsible for this module:				
Prof. Dr. Stefan Fischer				
Teacher:				
 Institute of Telematics 				

• Prof. Dr. Stefan Fischer



• Dr. rer. nat. Florian-Lennert Lau

Literature:

• Andrew S. Tanenbaum: Moderne Betriebssysteme - 3., aktualisierte Auflage, Pearson, April 2009

- James Kurose, Keith Ross: Computer Networking Der Top-Down-Ansatz Pearson Studim, 2012
- Andrew S. Tanenbaum: Computernetzwerke Pearson Studium, 2012

Language:

• offered only in German

Notes:

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

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

Module Exam(s):

- CS2150-L1: Operating Systems and Networks, written exam, 90min, 100% of the module grade.



	CS2301-KP06, CS2301 - Lab Course	Software Engineering	(SWEngPrakt)
uration:	Turnus of offer:	Credit points:	Max. group size:
Semester	each summer semester	6 (Тур А)	12
Course of study, spec Bachelor Media Bachelor Comp Bachelor Robot Bachelor Medic Bachelor Comp	cific field and term: a Informatics 2020 (compulsory), computer scien- buter Science 2019 (compulsory), foundations of tics and Autonomous Systems 2020 (compulsory cal Informatics 2019 (compulsory), computer scie buter Science 2016 (compulsory), foundations of	ce, 4th semester computer science, 4th seme /), computer science, 4th sen nce, 4th semester computer science, 4th seme:	ster nester ster
 Bachelor Robot Bachelor IT-Sec Bachelor Media Bachelor Medic Bachelor Comp 	tics and Autonomous Systems 2016 (compulsory curity 2016 (compulsory), computer science, 4th s a Informatics 2014 (compulsory), foundations of c cal Informatics 2014 (compulsory), computer scie puter Science 2014 (compulsory), foundations of), computer science, 4th sem semester computer science, 4th semes nce, 4th semester computer science, 4th semes	iester ster ster
Classes and lectures:		Workload:	
Lab Course Sof	tware Engineering (practical course, 4 SWS)	 60 Hours in-classro 60 Hours group wo 50 Hours work on 10 Hours oral press preparation) 	oom work ork project entation and discussion (including
Contents of teaching	:		
 Realization of a Project manage Design, implem 	a software system ement and team work nentation and testing		
 The students at techniques. They can use U They can decid They can contr They have the control of the start of the s	re able to systematically design software system IML and CASE tools. Ie how to advance their software in a sensible wa ibute their experience in the realization of a soft qualification to present artefacts, to comply tosta ied to work in a team and to reflect their social s	s whose implemention meet ay. ware development project ir andards and to observe time kills.	ts the requirements, using object oriented In further projects. E limits.
Grading through:			
 continuous, suc presentation successful addr documentation 	ccessful participation in practical course ressing of the project goals n		
Requires:			
Introduction toAlgorithms andSoftware Engin	Programming (CS1000-KP10, CS1000SJ14) Data Structures (CS1001-KP08, CS1001) eering (CS2300-KP06, CS2300SJ14)		
Responsible for this r	module:		
Prof. Dr. Martin	Leucker		
Teacher:			
Institute of Soft	tware Technology and Programming Languages		
• Prof. Dr. Martin	Leucker		
l itaratura:			
Prof. Dr. Martin erature: H. Balzert: Lehr	buch der Softwaretechnik: Softwaremanagemer	ıt - Spektrum Aka	demischer



• B. Brügge, A. H. Dutoit: Objektorientierte Softwaretechnik mit UML, Entwurfsmustern und Java - Pearson Studium 2004

- I. Sommerville: Software Engineering Addison-Wesley 2012
- B. Oestereich: Analyse und Design mit der UML 2.3 Objektorientierte Softwareentwicklung Oldenbourg 2009

Language:

offered only in German

Notes:

Admission requirements for taking the module:

- Passing the module CS2300-KP06 Software Engineering is a prerequisite for taking this module.

It is recommended to take this practical course directly after CS2300-KP06 Software Engineering.

Admission requirements for participation in module examination(s):

- Successful participation in the internship as specified at the beginning of the semester.

Module Exam(s):

- CS2301-L1: Internship Software Engineering, graded internship, 100% of module grade.



MA2510-KP04, MA2510 - Stochastics 1 (Stoch1)					
Duration: Turnus of off	er:	Credit points:			
1 Semester each summer	emester each summer semester				
 Course of study, specific field and term: Minor in Teaching Mathematics, Bachelor of Arts 2023 (compulsory), mathematics, 8th semester Bachelor CLS 2023 (compulsory), mathematics, 2nd semester Bachelor MES 2020 (optional subject), mathematics / natural sciences, 3rd semester at the earliest Bachelor Biophysics 2024 (optional subject), mathematics, 6th semester Bachelor Computer Science 2019 (compulsory), mathematics, 4th semester Bachelor Robotics and Autonomous Systems 2020 (compulsory), mathematics, 4th semester Bachelor Medical Informatics 2019 (optional subject), mathematics, 4th semester Bachelor Computer Science 2016 (compulsory), mathematics, 4th semester Bachelor Computer Science 2016 (compulsory), mathematics, 4th semester Bachelor CLS 2016 (compulsory), mathematics, 4th semester Bachelor Robotics and Autonomous Systems 2016 (compulsory), mathematics, 4th semester Bachelor Robotics and Autonomous Systems 2016 (compulsory), mathematics, 4th semester Bachelor Robotics and Autonomous Systems 2016 (compulsory), mathematics, 4th semester Bachelor Robotics and Autonomous Systems 2016 (compulsory), mathematics, 4th semester Bachelor Robotics and Autonomous Systems 2016 (compulsory), mathematics, 4th semester Bachelor Robotics and Autonomous Systems 2016 (compulsory), mathematics, 4th semester Bachelor Robotics and Autonomous Systems 2016 (compulsory), mathematics, 4th semester Bachelor Robotics 2016 (compulsory), mathematics, 6th semester Bachelor Medical Informatics 2014 (optional subject), mathematics, 5th or 6th semester Bachelor Medical Informatics 2014 (optional subject), mathematics, 4th semester Bachelor Medical Informatics 2014 (compulsory), mathematics, 4th semester Bachelor Medical Informatics 2014 (compulsory), mathematics, 5th or 6th semester Bachelor Medical Informatics 2014 (compulso					
Bachelor CLS 2010 (compulsory), mathematics, 2nd	semester				
Classes and lectures: • Stochastics 1 (lecture, 2 SWS) • Stochastic 1 (exercise, 1 SWS)	Workload: • 65 Ho • 45 Ho • 10 Ho	ours private studies and exercises ours in-classroom work ours exam preparation			
Contents of teaching: probability spaces basics of combinatorics conditional probability and stochastic independent random variables important discrete and continuous one-dimensional characteristics of distributions law of large numbers, central limit theorem modeling examples from the life sciences 	Contents of teaching: probability spaces basics of combinatorics conditional probability and stochastic independency random variables important discrete and continuous one-dimensional probability distributions characteristics of distributions law of large numbers, central limit theorem medoling oxamples from the life sciences 				
 Qualification-goals/Competencies: Students are able to explain basic stochastic models formally correct and in the context of their application They are able to formalize stochastic problems They are able to identify basic combinatorial patterns and to use them for solving stochastic problems They understand central statements of elementary stochastics 					
Grading through: written exam 					
Is requisite for: Stochastic processes (MA4610-KP05) Stochastic processes and modeling (MA4610-KP04, Modeling Biological Systems (MA4450-KP08, MA44 Modeling Biological Systems (MA4450-KP07) Module part: Modeling Biological Systems (MA4450 Module part: Modeling Biological Systems (MA4450 Modeling Biological Systems (MA4450) Modeling Biological Systems (MA4450) Modeling (MA4449-KP07)	MA4610) 50-MML)) T-INF)) T)				



Module part: Stochastics 2 (MA4020 T)
Stochastics 2 (MA4020-KP05)
Stochastics 2 (MA4020-MML)
 Stochastics 2 (MA4020-KP04, MA4020)
Responsible for this module:
Nachfolge von Prof. Dr. rer. nat. Karsten Keller
Teacher:
Institute for Mathematics
Nachfolge von Prof. Dr. rer. nat. Karsten Keller
Literature:
N. Henze: Stochastik für Einsteiger - Vieweg
U. Krengel: Einführung in die Wahrscheinlichkeitstheorie - Vieweg
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
Module exam(s):
- MA2510-L1: Stochastics 1, written exam, 90 min, 100 % of module grade





ME2700-KP08, ME2	700 - Fundamentals	of Electrical Enginee	ering 2 (ETechnik2)	
Duration: T	ation: Turnus of offer:		Credit points:	
1 Semester e	ach summer semester		8	
Course of study, specific field and term: Bachelor Computer Science 2019 (option Bachelor MES 2020 (compulsory), electric Bachelor Robotics and Autonomous System Bachelor MES 2011 (optional subject), electric Bachelor Computer Science 2016 (option Bachelor Robotics and Autonomous System Bachelor MES 2014 (compulsory), electric	onal subject), Extended og rical engineering, 4th sem stems 2020 (compulsory) electrical engineering, 4th onal subject), advanced cu stems 2016 (compulsory), rical engineering, 4th sem	otional subjects, Arbitrary lester , electrical engineering, 41 to 6th semester urriculum, Arbitrary semes Robotics and Autonomou lester	semester th semester ter us Systems, 4th semester	
Classes and lectures:		Workload:		
 Fundamentals of Electrical Engineering Fundamentals of Electrical Engineering 	2 (lecture, 4 SWS) 2 (exercise, 2 SWS)	 125 Hours private 90 Hours in-class 25 Hours exam p 	e studies room work reparation	
Contents of teaching: • Periodic and non-periodic waveforms				
 Transient response of basic linear circuits AC circuit analysis Frequency responses and Nyquist plot Physical basics of semiconductors Diodes Bipolar Transistors Field-effect transistors Operational amplifier Integrated circuits AD and DA converter Basic electronic circuits Introduction into the simulation of electrical circuits 				
Qualification-goals/Competencies: • Students know and understand the base • Students can assess frequency respons • Students can develop and analyze active • Students know the main semiconductor • Students recognize and understand the • Students can design and modify their of • Students are capable of simulating electrons	sics of AC circuit analysis a e plots of electrical circuit ve and passive analog filte or elements and their basi e most relevant electronic own circuits by modifying ctrical circuits and know h	and know how to apply it. and evaluate their conse ers. c circuits. c circuits. and combining elementa ow to use basic features c	equences. ry circuits. of the PSpice simulator.	
Grading through: • Written or oral exam as announced by t	the examiner			
Is requisite for: • Medical Electrical Engineering Lab Court	rse (ME3400-KP04, ME340	10)		
Requires: • Fundamentals of Electrical Engineering	1 (ME2400-KP08, ME2400))		
Responsible for this module: • Prof. Dr. Philipp Rostalski Teacher: • Institute for Electrical Engineering in Ma • Prof. Dr. Philipp Rostalski	edicine			



Literature:

- Agarwal, Lang: Foundations of Analog and Digital Circuits Elsevier; ISBN: 1-55860-735-8
- S. Goßner: Grundlagen der Elektronik. Halbleiter, Bauelemente und Schaltungen ISBN: 3826588258

Language:

• offered only in German

Notes:

Admission requirements for taking the module:

- None (the competencies of the modules listed under



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 Computer Science 2019 (compulsory), foundations of computer science, 2nd semester • Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 5th or 6th semester • Bachelor Media Informatics 2019 (compulsory), computer science, 2nd semester • Bachelor Media Informatics 2019 (compulsory), computer science, 2nd semester • Bachelor Media 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 Computer Science 2014 (compulsory), computer science, 3rd semester • Bachelor Computer Science 2014 (compulsory), foundations of computer science, 3rd semester • Bachelor Medical Informatics 2011 (compulsory), computer science, 1st semester • Bachelor Medical Informatics 2011 (computer science, 3rd semester • Bachelor MES 2011 (optional subject), computer science, 3rd semester • Bachelor CLS 2010 (optional subject), computer science, 6th semester • Bachelor CLS 2010 (optional subject), computer science, 6th semester • Bachelor Computer Science 2012 (compulsory), foundations of computer science, 1st semester • Bachelor Computer Science 2012 (compulsory), foundations of computer science, 1st semester • Bachelor Computer Science 2012 (compulsory), foundations of computer science, 1st semester • Bachelor Computer Science 2012 (compulsory), foundations of computer scien					
Classes and lectures:		Workload:			
 Introduction to Logic (lecture, 2 SWS) Introduction to Logic (exercise, 1 SWS) Introduction to Logic (exercise, 1 SWS) 10 Hours exam preparation 					
 Contents of teaching: 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 th • They are able to apply formal s • They are able to transfer meth • They are abel to formalize disc • They are able to modify proof	e concepts of syntax and semar systems and proof systems ods of mathematical logic to sin rete problems templates in order to create sim	tics for the examples of prepositional and predicate logic Iple practical problems ple 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. Rüdiger Reischuk					
Literature: • Uwe Schöning: Logik für Inforr	natiker - 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 Robotics and Autonomous Systems 2016 (optional subject), 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 Medical Informatics 2011 (compulsory: aptitude test), medical computer science, 1st semester Bachelor Medical Informatics 2011 (compulsory: aptitude test), medical computer science, 1st semester Bachelor Medical Informatics 2011 (compulsory: aptitude test), medical computer science, 1st semester Bachelor MES 2011 (compulsory), foundations of computer science, 3rd semester Bachelor MES 2011 (compulsory), specialization field medical informatics, 1st semester Bachelor Computer Science 2012 (compulsory), specialization field medical informatics, 1st semester Bachelor Computer Science 2012 (compulsory), specialization field medical informatics, 1st semester Bachelor Computer Science 2012 (compulsory), specialization field medical informatics, 1st semester Bachelor Computer Science 2012 (compulsory), specialization field medical informatics, 1st semester Bachelor Computer Science 2012 (compulsory), specialization field medical informatics, 1st semester Bachelor Computer Science 20					
Classes and lectures:		Workload:			
Introduction to Medical InformaticsIntroduction to Medical Informatics	InterestInterestInterest• 55 Hours private studiesInterest• 55 Hours private studiesInterest• 45 Hours in-classroom work• 20 Hours exam preparation				
 20 Hours exam preparation 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 the healthcare sector Conceptual systems in delical informatics 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 fundamental terms and selected methods in the area of medical informatics. They are able to formulate the objectives and types of medical databases. They are able to formulate the objectives 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 imaging. 					
Grading through:					
 written exam Responsible for this module: Prof. Dr. rer. nat. habil. Heinz Handels Teacher: 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



CS1601-KP04, CS1601 - Basics of Multimedia Systems (MMTechnik)					
Duration:	Turnus of offer:		Credit points:		
1 Semester each winter semester			4		
 Course of study, specific field and term: Bachelor Biophysics 2016 (optional subject), computer science, 5th semester Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester Bachelor Media Informatics 2020 (compulsory), media informatics, 3rd semester Bachelor Robotics and Autonomous Systems 2020 (optional subject), media informatics, 5th or 6th semester Bachelor Computer Science 2016 (optional subject), major subject informatics, Arbitrary semester Bachelor Robotics and Autonomous Systems 2020 (optional subject), computer science, 4th or 6th semester Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 4th or 6th semester Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 4th or 6th semester Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th semester Bachelor Robotics 2014 (optional subject), contral topics of computer science, 5th semester Bachelor Cus 2010 (optional subject), computer science, 6th semester Bachelor CLS 2010 (optional subject), computer science, 6th semester Bachelor CLS 2010 (optional subject), computer science, 5th semester Bachelor CLS 2010 (optional subject), computer science, 6th semester Bachelor Cles 2012 (compulsory), specialization field media informatics, 2nd semester Bachelor Ripotycisc 2024 (ontional subject), computer science, 5th semester 					
Classes and lectures: • Basics of Multimedia Systems (lect • Basics of Multimedia Systems (exe	Classes and lectures:Workload:• Basics of Multimedia Systems (lecture, 2 SWS)• 55 Hours private studies• Basics of Multimedia Systems (exercise, 1 SWS)• 45 Hours in-classroom work• 20 Hours exam preparation				
Contents of teaching: Sensation and Perception Analog Media Technology Digitalisation Digital Audio, Image and Video Technology Media storage (compression / formats) Media Transmission (Broadcast / Streaming) Qualification-goals/Competencies: Students are able to present to essential functions and principles of multimedia systems. They are able to judge possibilities and limitations of human perception. 					
 They can balance the specific advalation They are able to apply appropriate 	antages and disadvantages o e technical components and	f analog and digital media processes for the design of	technology. multimedia systems.		
Grading through: • Written or oral exam as announce	d by the examiner				
Responsible for this module: Prof. DrIng. Andreas Schrader Teacher: Institute of Telematics Prof. DrIng. Andreas Schrader 					
Literature: • Thomas Görne: Tontechnik - 4. Au • Ulrich Schmidt: Professionelle Vide	flage, Hanser 2014 eotechnik - 6. Auflage, Spring	jer 2013			
 Language: English, except in case of only German-speaking participants 					
Notes:					



Admission requirements for taking the module: - None

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

Module Exam(s):

- CS1601-L1 Fundamentals of Multimedia Technology, as determined by the instructor: Written exam, 90min, 100% of module grade OR oral exam, 100% of module grade.



CS2000-KP08, CS2000 - Theoretical Computer Science (TI)				
Duration: 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 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 Media Informatics 2014 (compulsory), computer scienc				
Bachelor Medical Informatics 2011 (Bachelor Computer Science 2012 (cc	compulsory), computer scie ompulsory), foundations of	ence, 3rd semester computer science, 3rd sem	ester	
Classes and lectures:	, ,,, ,, ,,, ,,,,,,,,,,,,,,,,,,,,,,,,,,	Workload:		
 Theoretical Computer Science (lecture) Theoretical Computer Science (exercised) 	Classes and lectures: Workload: • Theoretical Computer Science (lecture, 4 SWS) • 135 Hours private studies and exercises • Theoretical Computer Science (exercise, 2 SWS) • 90 Hours in-classroom work • 15 Hours exam preparation			
 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 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

Language:

offered only in German

Notes:

Admission requirements for taking the module:

- None (the competences of the modules indicated under





CS2100-KP04, CS2100SJ14 - Computer Architecture (RA14)					
Duration:	ration: Turnus of offer: Credit points:				
emester each summer semester 4			4		
Course of study, specific field and term: Bachelor Media Informatics 2020 (op Bachelor Computer Science 2019 (co Bachelor Robotics and Autonomous Bachelor Medical Informatics 2019 (co Bachelor Computer Science 2016 (co Bachelor Robotics and Autonomous Bachelor IT-Security 2016 (compulso Bachelor Medical Informatics 2014 (co Bachelor Computer Science 2014 (co	tional subject), computer s mpulsory), foundations of Systems 2020 (optional su optional subject), computer mpulsory), foundations of Systems 2016 (optional su ry), computer science, 4th optional subject), computer mpulsory), foundations of	science, 5th or 6th semeste computer science, 4th sem ibject), computer science, 5 r science, 4th to 6th semest computer science, 4th sem ject), computer science, 4th semester r science, 5th or 6th semest computer science, 4th sem	r iester ith or 6th semester ter nester n semester ter nester		
Classes and lectures:		Workload:			
 Computer Architecture (lecture, 2 SV Computer Architecture (exercise, 1 S 	VS) WS)	 60 Hours private 45 Hours in-class 15 Hours exam p 	studies room work preparation		
Contents of teaching: • Basic terms and concepts • Processor architectures • Computer components • Parallel computer architectures • Multiprocessors, multicomputer • Vector processors, array processors • Performance evaluation					
 Qualification-goals/Competencies: The students are able to elucidate th enhancement (caches, pipelining, VI They are able to explain important compare able to discuss and compare computers, array computers etc.). They are able to judge and make use 	e microarchitecture of mo IW, multi/manycore, virtua omputer components (bus e the most important para e of methods for performan	dern processors and the co ilization etc.). sses, storage hierachies, I/O Ilel computer architectures nce evaluation (benchmark	prresponding methods for performance units). G (multiprocessors, multicomputers, vector S, monitoring, queuing models etc.).		
Grading through: • Written or oral exam as announced b	by the examiner				
Requires: • Fundamentals of Computer Enginee	ring 1 (CS1200-KP06, CS12	00SJ14)			
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 Studium 2012 W. Stallings: Computer Organization and Architecture - Pearson Education 2012 A.S. Tanenbaum, T. Austin: Structured Computer Organization - Pearson Education 2012 					

Language:



offered only in German

Notes:

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





CS2250-KP04 - Cybersecurity (CyberSec04)						
Duration:	Turnus of offer: Cre		Credit points:			
1 Semester	each summer semester		4			
Course of study, specific field and terr • Bachelor MES 2020 (optional sub • Bachelor Media Informatics 2020 • Bachelor Computer Science 2019 • Bachelor Robotics and Autonome • Bachelor Medical Informatics 201	n: ject), computer science / elect (optional subject), computer s (compulsory), foundations of ous Systems 2020 (optional su 9 (optional subject), computer	rical engineering, 3rd seme science, 5th or 6th semeste computer science, 4th sem ıbject), computer science, 5 r science, 4th to 6th semest	ester at the earliest r nester 5th or 6th semester ter			
Classes and lectures:		Workload:				
 Cybersecurity (lecture, 2 SWS) Cybersecurity (exercise, 1 SWS) 	 Cybersecurity (lecture, 2 SWS) Cybersecurity (exercise, 1 SWS) 60 Hours private studies and exercises 40 Hours in-classroom work 20 Hours exam preparation 					
Contents of teaching:						
 Security problems in IT systems Security threats, risk analysis and Software and application security Security of operating systems Security of databases and web apprivacy Security oriented development, experience Legal, etical and economic aspection 	 Security problems in IT systems Security threats, risk analysis and defense mechanisms Software and application security Security of operating systems Security of databases and web applications Privacy Security oriented development, evaluation and penetration testing Legal, etical and economic aspects 					
 Qualification-goals/Competencies: Students can independently ider discussed in the course. They can explain the basic method They can independently perform They are able to identify method 	ntify security risks of software s ods in the area of cybersecurity a security analyses for simple so Is for eliminating weak points a	systems and explain the co y and apply them to case s cenarios. and implement concrete sc	mmon security solutions from the areas tudies. plutions.			
Grading through: • portfolio exam	Grading through: • portfolio exam					
Responsible for this module: Prof. DrIng. Thomas Eisenbarth Teacher: Institute for IT Security Prof. DrIng. Thomas Eisenbarth 						
Literature: • C. Paar, J. Pelzl: Understanding C • D. Gollmann: Computer Security • R. Anderson: Security Engineerin • M. Bishop: Introduction to Comp	ryptography - Springer, 2008 - Third Edition, Wiley, 2011 g - Second Edition, Wiley, 2008 uter Security - Addison-Wesley	3 1, 2005				
Language: German and English skills required						
Notes:						



Admission requirements for taking the module: - None

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

Module Exam(s):

- CS2250-L1 Cybersecurity, Portfolio examination, the specific examination elements and their weighting will be announced at the beginning of the semester, 100% of the module grade

The courses of this module are also part of CS2250-KP08.

(Share of Institute for IT Security in V is 100%) (Share of Institute for IT Security in Ü is 100%)



CS2600-KP08, CS2600SJ14 - Interaction Design and User Experience (IDE)				
Duration:	Turnus of offer: Credit points:			
Semester 8			8	
Course of study, specific field and term: • Bachelor Media Informatics 2020 (co • Bachelor Robotics and Autonomous • Bachelor Computer Science 2016 (op • Bachelor Robotics and Autonomous • Bachelor Computer Science 2014 (op • Bachelor Media Informatics 2014 (co	mpulsory), design, 4th seme Systems 2020 (optional sul otional subject), major subje Systems 2016 (optional sub otional subject), central topi mpulsory), media informati	ester oject), computer science, 51 ect informatics, Arbitrary se oject), computer science, 5t cs of computer science, 6th cs, 4th semester	th or 6th semester mester h or 6th semester n semester	
Classes and lectures:		Workload:		
 Interaction Design (lecture, 4 SWS) Interaction Design (exercise, 2 SWS) 		 120 Hours private 90 Hours in-classr 30 Hours exam pr 	e studies room work reparation	
Contents of teaching:				
 Contents of teaching: Introduction and overview A short history of Human Computer Interaction (Definition and distinction: Software Ergonomics vs Usability Engineering vs Interaction Design Usability as design goal: central models and ISO norms, fundamentals of software ergonomic and cognition (a brief review of Software Ergonomics) User Experience (UX) as new design goal: Models and background (i.e. pleasurable products, hedonistic and pragmatic quality, emotional design) UX as aesthetic and emotional appeal UX as aesthetic and emotional appeal UX as aesthetic and emotion Design: From Human-Centered Design based on the ISO-Norm to the simplified Four-Phase-Model Iterative Design as mental models in action: Design Model, User Model and System Image Phase 1 of Interaction Design: 'Understand' (Practical methods of design ethnography and context analysis; representation of users and tasks) Phase 2 of Interaction Design: 'design' (system's paradigms: HCI as conversation, HCI as model-world, Direct Manipulation, Tangible Interaction, Proxemic Interaction, Virtual Reality; Sketching User Experiences for idea generation and solution development; design principles and guidelines as decision support, i.e. Normans' principles, gestalt laws, Human Interface Guidelines; theoretical models and techniques from research vs. design practice) Phase 4 of Interaction Design: 'Wall' (basic principles of Prototyping; Low- vs. High-Fidelity-Prototyping; Time vs. Fidelity: Sketching, Paper Prototyping, Wireframes/Click-Through, Dynamic Prototyping; Low- vs. High-Fidelity-Prototyping; Time vs. Fidelity: Sketching, Paper Prototyping, Wireframes/Click-Through, Dynamic Prototypes, Coded Prototypes; Prototyping tools in practice) Phase 4 of Interaction Design. 'Evaluate' (analytic vs empirical methods in practices; evaluation of users experience with standardized questionnaires; formative vs. summative evaluation				
 Qualification-goals/Competencies: The students are able to use systematically and theoretically founded methods for the design of user interfaces of interactive systems. The students are able to use their knowledge in Software Ergonomics, Media Design and Media Informatics in a realistic Interaction Design project They are capable of categorizing existing systems and develop concepts for improving them. They are capable of planning and designing human-computer interfaces with high user experience. 				
 Grading through: portfolio exam - the concrete examination elements and their weights will be published in the course • 				
Requires: • Software Ergonomics (CS2200-KP04, CS2200) • Introduction to Media Informatics (CS1600-KP04, CS1600)				



Responsible for this module:
Prof. Dr. rer. nat. Hans-Christian Jetter
Teacher:
Institute for Multimedia and Interactive Systems
Prof. Dr. rer. nat. Hans-Christian Jetter
MitarbeiterInnen des Instituts
Literature:
• H. Sharp, J. Preece, Y. Rogers: Interaction Design: Beyond Human-Computer Interaction - Wiley, 2019
R. Hartson, P. Pyla: The UX Book: Agile UX Design for a Quality User Experience - Morgan Kaufman, 2019
Michael Richter, Markus Flückiger: Usability und UX kompakt - Produkte für Menschen, 2015
 Saul Greenberg, Sheelagh Carpendale, Nicolai Marquardt, Bill Buxton: Sketching User Experiences - The Workbook, 2012
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):
- Preliminary examinations may be required and will be announced at the beginning of the semester.
Module Exam(s):
- CS2600-L1 Interaction Design and User Experience, oral exam, 50% of the module grade
- CS2600-L1 Interaction Design and User Experience, portfolio exam, 50% of the module grade during the semester
Poplaces CS2600 KP08 Interaction Design
heplaces C32000-Kr 00 Interaction Design



	CS2700-KP04, CS27	700 - Databases (DB)
Duration:	Turnus of offer:	Credit points:
1 Semester	each winter semester	4
Course of study, specific field and Bachelor Biophysics 2024 (o Bachelor MES 2020 (optional Bachelor Media Informatics Bachelor Computer Science Bachelor Robotics and Auto Bachelor Medical Informatic Bachelor Computer Science Bachelor Robotics and Auto Bachelor Robotics and Auto Bachelor Robotics and Auto Bachelor IT-Security 2016 (c Bachelor Biophysics 2016 (o Bachelor MES 2011 (optional Bachelor Medical Informatics Bachelor Media Informatics Bachelor Media Informatics Bachelor Computer Science Bachelor Computer Science Bachelor CLS 2010 (optional s Bachelor CLS 2010 (optional s	l term: ptional subject), computer science, l subject), computer science / elect 2020 (compulsory), computer scien 2019 (compulsory), foundations of nomous Systems 2020 (optional su 2016 (compulsory), computer scie 2016 (compulsory), foundations of nomous Systems 2016 (optional sul ompulsory), computer science, 3rd ptional subject), computer science, 4th or s 2014 (compulsory), computer science il subject), computer science / elect 2014 (compulsory), foundations of 2014 (compulsory), foundations of s 2011 (compulsory), computer science ubject), computer science, 2nd sem subject), computer science, 6th se 2012 (compulsory) foundations of	6th semester rical engineering, 3rd semester at the earliest ce, 5th semester computer science, 3rd semester ibject), computer science, 5th or 6th semester ence, 3rd semester computer science, 4th semester bject), computer science, 5th or 6th semester semester 6th semester • 6th semester • 6th semester ence, 4th semester rical engineering, 4th or 6th semester computer science, 4th semester ence, 2nd semester ence, 2nd semester
Classes and lectures: • Databases (lecture, 2 SWS) • Databases (exercise, 1 SWS)		Workload: • 55 Hours private studies • 45 Hours in-classroom work • 20 Hours exam preparation
Contents of teaching:		
 Introduction, conceptual vie The relational data model* and relationships into the reduction of relation, cloudecomposition of relation s Practical query language: SG management* Integrity con Storage structures and data manager, buffer manager, f Query processing* Indexing selection trees, query execution partition-based join with ha Datalog* Syntax, semantics, 	w of database systems, conceptual Referential integrity, keys, foreign k Plational data model* Update, inser- sure w.r.t. FD set, canonical cover o chemata, multi-value dependencies QL* Selection, projection, join, aggre straints base architecture* Characteristics o iles and access methods, record allo techniques, ISAM index, B+-tree in tion plans, join operator: nested loo shing* Addition operators: groupin treatment of negation (stratificatic	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, and duplicate elimination, selection, projection, pipeline principle on)* 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-KP10, 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.



	CS3000-KP04, CS3000 - Alg	gorithm Design (Algo	oDesign)
Duration:	Turnus of offer:		Credit points:
1 Semester	each winter semester		4
Course of study, specific field and t Master CLS 2023 (optional sul Bachelor Computer Science 2 Bachelor Robotics and Autono Bachelor Medical Informatics Bachelor Computer Science 2 Master CLS 2016 (optional sul Bachelor Robotics and Autono Bachelor IT-Security 2016 (cor Bachelor Medical Informatics Bachelor Computer Science 2 Bachelor CLS 2010 (optional sul Bachelor CLS 2010 (optional sul Bachelor CLS 2010 (optional sul Bachelor Computer Science 2	cerm: bject), computer science, 3rd sem 019 (compulsory), foundations of pmous Systems 2020 (optional su 2019 (optional subject), compute 016 (compulsory), foundations of bject), computer science, 3rd sem pmous Systems 2016 (optional su npulsory), computer science, 5th 2014 (optional subject), compute 014 (compulsory), foundations of ubject), computer science, 5th or 012 (compulsory), foundations of	ester computer science, 5th set ubject), computer science, r science, 4th to 6th seme computer science, 5th set ester bject), computer science, semester r science, 5th or 6th seme computer science, 5th set 6th semester computer science, 5th set	mester , 5th or 6th semester ster mester 5th or 6th semester ster mester mester
Classes and lectures:		Workload:	
 Algorithm Design (lecture, 2 S Algorithm Design (exercise, 1 	SWS) SWS)	65 Hours privat45 Hours in-class10 Hours exam	e studies and exercises ssroom work preparation
Contents of teaching:			
 Complex data structures and Efficiency analysis and correct Probabilistic algorithms Online algorithms Graph, matching and schedul String processing Approximation algorithms 	union find data structures mess proofs ing problems		
Qualification-goals/Competencies:			
 The students can safely apply They can analyze algorithms They are able to apply these p They can contribute their pro 	the principles of algorithm desig with respect to correctness and e principles to concrete problems. ficiency in solving similar algorith	ın. fficiency. ımic problems.	
Grading through:			
• written exam			
Requires: • Stochastics 1 (MA2510-KP04, • Theoretical Computer Science • Algorithms and Data Structure	MA2510) • (CS2000-KP08, CS2000) es (CS1001-KP08, CS1001)		
Responsible for this module:			
Prof. Dr. Rüdiger Reischuk			
Teacher:	utor Scionco		
 Institute for Theoretical Comp Prof. Dr. Rüdiger Reischuk Prof. Dr. rer. nat. Till Tantau 	DULER SCIENCE		
Literature:			
• J. Kleinberg, E. Tardos: Algorit	hm Design - Addison Wesley, 200)5	



- T. Cormen, C. Leiserson, R. Rivest, C. Stein: Introduction to Algorithms MIT Press, 2009
- S. Skiena: The Algorithmic Design Manual Springer, 2012

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 and project assignments as specified at the beginning of the semester.

Module exam(s):

- CS3000-L1: Algorithm Design, written exam, 90 min, 100 % of module grade



255010	-KP04, CS3010 - Huma	n-Computer-Interact	tion (MCI)
Duration:	Turnus of offer:		Credit points:
1 Semester	each winter semester		4
Course of study, specific field and term: Master Entrepreneurship in Digital Bachelor Computer Science 2019 (c Bachelor Robotics and Autonomous Bachelor Medical Informatics 2019 (Master Biophysics 2019 (optional su Master Psychology 2016 (optional su Bachelor Computer Science 2016 (c Bachelor IT-Security 2016 (compulse Bachelor Robotics and Autonomous Master Entrepreneurship in Digital Master psychology 2013 (optional s Master Medical Informatics 2014 (optional s Master Medical Informatics 2014 (c) Bachelor Computer Science 2014 (c) Bachelor Medical Informatics 2014 (c) Master Me	Technologies 2020 (optional ompulsory), foundations of Systems 2020 (optional su optional subject), computer bject), Elective, 1st semeste ubject), interdisciplinary con ompulsory), foundations of Systems 2016 (optional sub Technologies 2014 (optional ubject), interdisciplinary cor otional subject), computer so ompulsory), foundations of optional subject), computer	subject), interdisciplinary computer science, 5th sem bject), computer science, 5 science, 4th to 6th semest r npetence, 3rd semester at computer science, 5th sem semester bject), computer science, 5 subject), interdisciplinary npetence, 3rd semester cience, 1st or 2nd semester computer science, 5th sem science, 5th or 6th semest	competence, Arbitrary semester hester 5th or 6th semester ter the earliest hester th or 6th semester competence, Arbitrary semester r hester ter
Classes and lectures:		Workload:	
 Human-Computer-Interaction (lecture, 2 SWS) Human-Computer-Interaction (exercise, 1 SWS) 45 Hours in-classroom work 20 Hours exam preparation 		studies room work reparation	
Contents of teaching:			
 Introduction and overview of the to Norms and legal foundations Human information processing and Models for human-computer syster Input/Output devices and interactio User-centered development process Usability Engineering System paradigms and correspondi Evaluation and impact analyzes Innovative concepts and systems 	pic area processes of actions ns and interactive media on technologies s and special groups of user ng system examples	S	
Qualification-goals/Competencies:			
 The students know the principles at They have basic knowledge about the They know the basic models of interesting to analyze and 	nd methods of the context-, numan information processi ractive systems und can app I review interative systems k	task- and user-centered de ng and can introduce it int oly them for their analysis a pased on criteria.	evelopment of interactive systems. to the design process. and evaluation.
Grading through: • written exam			
Responsible for this module:			
Prof. DrIng. Nicole Jochems			
Teacher: Institute for Multimedia and Interac	tive Systems		
Prof. Dr. Ing. Nicolo. Joshoms			
Literature: • M. Dahm: Grundlagen der Mensch- • J.A. Jacko: The Human-Computer In	Computer-Interaktion - Pear teraction Handbook - CRC P	son Studium, 2006 ress, 2012	



Language:

• offered only in German

Notes:

Prerequisites for attending the module: - None

Prerequisites for the exam:

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

Exam(s):

- CS3010-L1 Mensch-Computer-Interaktion, Klausur, 90min, 100% der Modulnote



(S3051-KP04, CS3051 - Pa	rallel Computing (Pa	ırallelVa)
Duration:	Turnus of offer:		Credit points:
1 Semester	normally each year in th	e summer semester	4
Course of study, specific field and t	erm:		
Course of study, specific field and t Bachelor Computer Science 2 Bachelor Computer Science 2 Bachelor Media Informatics 20 Bachelor Robotics and Autom Bachelor Computer Science 2 Bachelor Computer Science 2 Bachelor Computer Science 2 Bachelor Robotics and Autom Bachelor IT-Security 2016 (op Master Medical Informatics 20 Bachelor Computer Science 2 Master Computer Science 20	term: 019 (optional subject), major sub 019 (optional subject), Canonical 020 (optional subject), computer omous Systems 2020 (optional s 016 (optional subject), Canonical 016 (optional subject), major sub 016 (optional subject), Canonical omous Systems 2016 (optional su- cional subject), computer science 014 (optional subject), computer 014 (optional subject), central to 2 (optional subject), advanced c	oject informatics, Arbitrary Specialization SSE, 4th se science, 5th or 6th semest ubject), computer science Specialization Web and D oject informatics, Arbitrary Specialization SSE, 4th se ubject), computer science, e, Arbitrary semester science, 1st or 2nd semest pics of computer science, urriculum programming, 2	semester mester ter , 5th or 6th semester Data Science, 4th semester semester mester 5th or 6th semester ter 5th or 6th semester 2nd and 3rd semester
 Bachelor Computer Science 2 Master Computer Science 201 	012 (optional subject), central to 2 (optional subject), advanced c	pics of computer science, urriculum algorithmics and	5th or 6th semester d complexity theory, 2nd or 3rd semester
Classes and lectures: • Parallel Computing (lecture, 2 • Parallel Computing (exercise,	SWS) 1 SWS)	Workload: • 65 Hours privat • 45 Hours in-cla • 10 Hours exam	te studies and exercises ssroom work preparation
 Parallel architectures Programming language supp Design methodologies for pa Implementation of parallel algorithms Parallel search and sorting Parallel graph algorithms Parallel formula evaluation Speedup, efficiency, parallel of Limits of parallelism and lower 	ort for parallel programming rallel algorithms gorithms omplexity classes er bounds		
Oualification-goals/Competencies:			
 Studentes are able to describ They are able to design and in They are able to analyze para They are able to describe the 	e the design and function of para nplement parallel algorithms. Ilel systems and programs. limits of parallel systems.	allel systems.	
Grading through:			
Viva Voce or test			
Requires:			
Theoretical Computer Science	e (CS2000-KP08, CS2000)		
Responsible for this module: • Prof. Dr. rer. nat. Till Tantau Teacher: • Institute for Theoretical Comp • Prof. Dr. rer. nat. Till Tantau	outer Science		
• Jaja: An Introduction to Parall	el Algorithms - Addison Wesley,	1992	



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

Language:

• offered only in German

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. Notes:

Admission requirements for taking the module:

- None (the competencies of the modules listed under



CS3201	-KP04, CS3201 - Usab	ility Engineering (Usa	abUXEng)
Duration:	Turnus of offer:		Credit points:
1 Semester	each winter semester		4
Course of study, specific field and term: Bachelor Media Informatics 2020 (co Bachelor Computer Science 2019 (o Bachelor Computer Science 2019 (co Bachelor Robotics and Autonomous Bachelor Computer Science 2016 (co Bachelor Computer Science 2016 (co Bachelor Robotics and Autonomous Bachelor Robotics and Autonomous Bachelor IT-Security 2016 (optional s Bachelor Media Informatics 2014 (co Bachelor Computer Science 2014 (co Bachelor Computer Science 2014 (co Bachelor Computer Science 2012 (co Bachelor Computer Science 2012 (co Bachelor Computer Science 2012 (co	ompulsory), media informat ptional subject), major subj ompulsory), Canonical Spec Systems 2020 (optional su ptional subject), major subj ompulsory), Canonical Spec Systems 2016 (optional su subject), computer science, ompulsory), media informat ptional subject), central top optional subject), central top optional subject), central top	ics, 5th semester ect informatics, Arbitrary se ialization SSE, 5th semeste ibject), computer science, 5 ect informatics, Arbitrary se ialization SSE, 5th semeste bject), computer science, 5 Arbitrary semester ics, 5th semester ics of computer science, 5t engineering, 4th to 6th ser ield media informatics, 6th ics of computer science, 6t	emester r 5th or 6th semester emester r th or 6th semester th semester nester semester th semester
Classes and lectures:		Workload:	
 Usability Engineering (lecture, 2 SW Usability-Engineering (exercise, 1 SV 	 Usability Engineering (lecture, 2 SWS) Usability-Engineering (exercise, 1 SWS) 		studies sroom work preparation
 Software- und Usability-Engineering Usability and UX target criteria for in Cost-benefit analysis Design and conception methods for Organizational and context analysis User analyses Task analyses Modeling and design of interactive Evaluation of interactive systems: pl Statistical methods of usability and Interdisciplinary teams and social pr Embedding usability and UX in busi 	nteractive systems r user experience systems anning, implementation ar UX evaluation rocesses ness processes	d evaluation	
 Qualification-goals/Competencies: Students can explain and implement You can adapt and apply the basic p They can apply usability and user explained their results. They can justify the influence of form human-centered development proce The exercise trains team skills, struct Grading through: written exam Requires: Software Ergonomics (CS2200, KP04) 	t the basic human-centered processes for development perience engineering meth mal and informal requireme esses. tured work, time managem	d development processes f projects to suit the probler nods in a targeted manner ents as well as complex soc ent and presentation skills.	for multimedia interactive systems. n. and evaluate, reflect on and communicate ial structures and behaviors on
Software Ergonomics (CS2200-RP04 Responsible for this module: Prof. Dr. phil. André Calero Valdez Teacher:	, C32200)		



Institute for Multimedia and Interactive Systems
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• 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



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



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



CS3420-KP04, CS3420 - Cryptology (Krypto14)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each winter semester		4	
 Course of study, specific field and term: Master CLS 2023 (optional subject), computer science, 3rd semester Bachelor Computer Science 2019 (optional subject), major subject informatics, Arbitrary semester Bachelor Media Informatics 2020 (optional subject), computer science, 4th or 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 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), major subject informatics, Arbitrary semester Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th or 6th semester Bachelor IT-Security 2016 (compulsory), IT-Security, 3rd semester Bachelor Medical Informatics 2014 (optional subject), computer science, 5th or 6th semester Bachelor Computer Science 2014 (optional subject), central topics of computer science, 5th or 6th semester 				
Classes and lectures:		Workload:		
 Cryptology (lecture, 2 SWS) Cryptology (exercise, 1 SWS) 45 Hours in-classroom work 10 Hours exam preparation 		studies and exercises room work reparation		
Contents of teaching: history of cryptography, classical systems mathematical and algorithmic basics design principles for cryptographic applications symmetric crypto systems public key crypto systems, digital signatures efficient implementation of crypto systems methods in cryptoanalysis cryptographic protocols Qualification-goals/Competencies: The students are able to model and analyze IT security. They know basic cryptographic primitives and protocols. They can recognize cryptographic weakness. They can apply standard techniques in cryptology. 				
Grading through:				
 written exam Responsible for this module: Prof. Dr. Maciej Liskiewicz Teacher: Institute for Theoretical Computer Sc Prof. Dr. Maciej Liskiewicz 	ience			
Literature: J von zur Gathen: CryptoSchool - Spr A. Beutelspacher, H. Neumann, T. Sch D. Wätjen: Kryptographie - Springer J. Katz, Y. Lindell: Introduction to Mo C. Bauer: Secret History - The Story o B. Schneier: Applied Cryptography -	inger 2015 nwarzpaul: Kryptopgrafie ir 2018 dern Cryptography - Chap f Cryptology - CRC Press 20 J. Wiley 1996	n Theorie und Praxis - View man & Hall, 2008)13	eg 2005	



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Language:
English, except in case of only German-speaking participants
Notes:
Admission requirements for taking the module: - None
Admission requirements for participation in module examination(s):
- Successful completion of exercise sheets as specified at the beginning of the semester
Module exam(s):
- CS3420-L1: Cryptology, written exam, 90 minutes, 100% of module grade


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



Notes:

Admission requirements for taking the module:

- None

Admission requirements for participation in module examination(s):

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

Module Exam(s):

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



MA3110-KP04, MA3110 - Numerics 1 (Num1KP04)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each winter semester		4	
I Semester 4 Course of study, specific field and term: 4 • Master Auditory Technology 2022 (optional subject), Elective, Arbitrary semester • Bachelor Computer Science 2019 (optional subject), Extended optional subjects, Arbitrary 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 2019 (optional subject), mathematics, 4th to 6th semester • Bachelor IT-Security 2016 (optional subject), mathematics, Arbitrary semester • Master Auditory Technology 2017 (optional subject), compulsory module depending on previous knowledge , 1st semester • Bachelor Computer Science 2016 (optional subject), advanced curriculum, Arbitrary semester • Bachelor Computer Science 2016 (optional subject), Canonical Specialization Web and Data Science, 3rd semester				
 Bachelor Robotics and Autonomous Systems 2016 (optional subject), mathematics, 5th or 6th semester Bachelor Medical Informatics 2014 (optional subject), mathematics, 5th or 6th semester Bachelor MES 2014 (optional subject), mathematics / natural sciences, 3rd or 5th semester Bachelor Computer Science 2014 (optional subject), central topics of computer science, 5th semester Master MES 2011 (optional subject), mathematics, 1st semester Bachelor MES 2011 (optional subject), mathematics, 3rd semester Bachelor Computer Science 2012 (optional subject), mathematics, 5th or 6th semester 				
Classes and lectures:		Workload:		
 Numerics 1 (lecture, 2 SWS) Numerics 1 (exercise, 1 SWS) 	(lecture, 2 SWS)• 55 Hours private studies(exercise, 1 SWS)• 45 Hours in-classroom work• 20 Hours exam preparation		studies room work reparation	
Contents of teaching: Round-off errors and condition Direct solvers for linear equations LR decomposition Perturbation theory Cholesky decomposition QR decomposition, least squares fit 				
Qualification-goals/Competencies:				
 Students understand basic numerical tasks. They are proficient in the modern programming language MATLAB. They can implement theoretical algorithms. They can assess the quality of a method (accuracy, stability, complexity). 				
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 (MA2500-KP04, MA2500)				
Responsible for this module: • Prof. Dr. rer. nat. Andreas Rößler Teacher:				
Institute for Mathematics				
Prof. Dr. rer. nat. Andreas Rößler				



Literature:

- M. Bollhöfer, V. Mehrmann: Numerische Mathematik Vieweg (2004)
- P. Deuflhard, A. Hohmann: Numerische Mathematik I 4. Auflage, De Gruyter (2008)
- P. Deuflhard, F. Bornemann: Numerische Mathematik II 3. Auflage, De Gruyter (2008)
- M. Hanke-Bourgeois: Grundlagen der Numerischen Mathematik und des Wissenschaftlichen Rechnens 3. Aufl., Teubner (2009)

Module Guide

- H. R. Schwarz, N. Köckler: Numerische Mathematik 6. Auflage, Teubner (2006)
- J. Stoer: Numerische Mathematik I 10. Auflage, Springer (2007)
- J. Stoer, R. Bulirsch: Numerische Mathematik II 5. Auflage, Springer (2005)
- A. M. Quarteroni, R. Sacco, F. Salieri: Numerical Mathematics 2. Auflage, Springer (2006)
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Language:

• offered only in German

Notes:

The lecture is identical to that in module MA3110-MML/Numerics 1.

Prerequisites for attending the module:

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

Prerequisites for the exam:

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

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MA3400-KP04, MA3400 - Biomathematics (Biomathe)			
Duration:	Turnus of offer:	Credit points:	
1 Semester	each winter semester	4	
Course of study, specific field and term: Master Molecular Life Science 2023 Bachelor MES 2020 (optional subject) Bachelor Robotics and Autonomous Bachelor Medical Informatics 2014 (c Bachelor MES 2014 (optional subject) Bachelor Computer Science 2014 (cc Master MES 2011 (optional subject), Bachelor Medical Informatics 2011 (c Master Computer Science 2012 (optional subject) Bachelor MES 2011 (optional subject) Bachelor MES 2011 (optional subject) Bachelor MES 2011 (optional subject) Bachelor Computer Science 2012 (optional subject) Bachelor Computer Science 2012 (control optional subject)	optional subject), mathem t), mathematics / natural so Systems 2020 (optional su optional subject), medical o t), mathematics / natural so ompulsory), specialization f mathematics, 1st semester optional subject), specializatio t), mathematics, 5th semes ompulsory), specialization f	atics / computer science, 1st semester iences, 3rd semester at the earliest ubject), mathematics, 5th or 6th semester computer science, 5th or 6th semester iences, 3rd or 5th semester ield bioinformatics, 5th semester natics, 4th to 6th semester n field medical informatics, 3rd semester ter	
Classes and lectures:		Workload:	
Biomathematics (lecture, 2 SWS)		• 55 Hours private studies and exercises	
Biomathematics (exercise, 1 SWS)		 45 Hours in-classroom work 20 Hours exam preparation 	
 20 Hours exam preparation Contents of teaching: Examples and elementary solution methods for ordinary differential equations 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 Qualification-goals/Competencies: Students are able to explain basic notions from the theory of ordinary differential 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. Students are able to present important models of the natural sciences which canbe analysed by differential equations. 			
• 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	erential 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



MA3445-KP04, MA3445 - Graph Theory (Graphen)				
Duration:	Turnus of offer:	Credit points:		
1 Semester	every second year	4		
Course of study, specific field and term: • Master MES 2020 (optional subject).	mathematics / natural scien	ces. Arbitrary semester		
 Bachelor MES 2020 (philonal subject), Bachelor Medical Informatics 2019 (c Bachelor IT-Security 2016 (optional s Bachelor Robotics and Autonomous Bachelor Medical Informatics 2014 (c Master MES 2014 (optional subject), Bachelor Computer Science 2014 (optional subject), r Master MES 2011 (optional subject), r Master MES 2011 (optional subject), Bachelor CLS 2010 (optional subject), Bachelor CLS 2010 (optional subject), Bachelor CLS 2010 (optional subject), 	Systems 2020 (optional sub optional subject), mathemat ubject), mathematics, Arbitr Systems 2016 (optional sub optional subject), mathemat mathematics / natural scien otional subject), central topio nathematics, Arbitrary seme mathematics, 1st or 2nd ser , mathematics, 5th or 6th se otional subject), mathematic	oject), mathematics, 5th or 6th semester ics, 4th to 6th semester rary semester ject), mathematics, 5th or 6th semester ics, 5th or 6th semester ces, 1st or 2nd semester ces of computer science, 5th or 6th semester ester mester emester cs, 5th or 6th semester		
Classes and lectures:		Workload:		
Graph theory (lecture, 2 SWS) Graph theory (exercise, 1 SWS) Graph theory				
Contents of teaching: Hamiltonian graphs and degree sequences Menger's theorem - new proofs Matchings and decompositions of graphs The theorems of Turan and Ramsey Vertex and edge colourings The four colour theorem Qualification-goals/Competencies: Ability to solve discrete problems using graph theoretical methods Knowledge of proof techniques and ideas of discrete mathematics Knowledge of fundamental and selected recent research results Grading through:				
 Requires: Linear Algebra and Discrete Structures 2 (MA1500-KP08, MA1500) Linear Algebra and Discrete Structures 1 (MA1000-KP08, MA1000) 				
Responsible for this module: • PD Dr. rer. nat. Christian Bey Teacher: • Institute for Mathematics • PD Dr. rer. nat. Christian Bey				
 Literature: F. Harary: Graph Theory - Reading, MA:.Addison-Wesley 1969 R. Diestel: Graphentheorie - Berlin: Springer 2000 D. Jungnickel: Graphen, Netzwerke und Algorithmen - Mannheim: BI-Wissenschaftsverlag1994 J. Bang-Jensen, G. Gutin: Digraphs: Theory, Algorithms and Applications - London: Springer 2001 B. Bollobas: Modern Graph Theory - Berlin: Springer 1998 				



Language:

• offered only in German

Notes:

Admission requirements for taking the module: - None (the competencies of the modules listed under "Requires" are required for this module, but are not a formal prerequisite).

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

Module Exam(s):

- MA3445-L1: Graph Theory, oral exam, 30 min, 100% of module grade.



ME2151-KP04, ME2151 - Introduction to Medical Engineering (EMedTecMI)					
Duration:	on: Turnus of offer:		Credit points:		
1 Semester	Semester each winter semester		4		
 Course of study, specific field and term: Bachelor Robotics and Autonomous Systems 2020 (optional subject), Robotics and Autonomous Systems, 5th or 6th semester Bachelor Robotics and Autonomous Systems 2016 (compulsory), Robotics and Autonomous Systems, 5th semester Bachelor Medical Informatics 2014 (compulsory), medical computer science, 3rd semester 					
Classes and lectures:Workload:• Introduction to Medical Engineering (lecture, 2 SWS)• 55 Hours private studies• Introduction to Medical Engineering (exercise, 1 SWS)• 45 Hours in-classroom work• 20 Hours exam preparation		studies room work reparation			
Contents of teaching: Fundamentals of medical measurement technology Methods of functional diagnostics Imaging systems Therapy systems Monitoring Medical informatics Important legal requirements Medical applications 					
 Qualification-goals/Competencies: Students know how different signals in the body are formed and can be measured. They understand the complex mechanisms involved in the metrology of physiological parameters. Students are able to explain the physical phenomena of relevant biological processes and methods of measurement. The students are able to transfer basic problems and solutions within the medical industry. Students will be able to understand basic signal processing processes and implement them using a simulation environment. Students are able to assess the advantages and disadvantages, as well as the limitations of each method. Students are able to explain the applications of different medical measuring systems. Students will have an overview of the current state of medical technology. 					
Grading through: • written exam					
Responsible for this module: • Prof. Dr. rer. nat. Thorsten Buzug Teacher: • Institute of Medical Engineering • DrIng. Ksenija Gräfe					
Literature: • R. Kramme (Hrsg.): Medizintechnik: Verfahren Systeme Informationsverarbeitung - Springer Verlag, 2011 • J. D. Enderle, J. D. Bronzino: Introduction to Biomedical Engineering - Elsevier, 2011					
Language: • German and English skills required					
Notes:					



Prerequisites for attending the module: - None

Prerequisites for the exam: - Successful completion of exercise sheets as specified at the beginning of the semester

Module examination(s):

- ME2151-L1: Introduction to medical technology, written exam, 90 min, 100 % of the module grade



ME3400-KP	04, ME3400 - Medical Electric	al Engineering Lab Course (METechPrak)		
Duration:	Turnus of offer:	Credit points:		
1 Semester	each winter semester	4 (Тур В)		
Course of study, specific field an • Bachelor MES 2020 (compu • Bachelor Robotics and Auto • Bachelor MES 2014 (compu • Bachelor Robotics and Auto	d term: Ilsory), electrical engineering, 5th sem phomous Systems 2016 (optional sub Ilsory), electrical engineering, 5th sem phomous Systems 2020 (optional sub	ester ject), electrical engineering, 5th or 6th semester lester ject), Additionally recognized elective module, 5th or 6th semester		
Classes and lectures: • Medical Electrical Engineering Lab Course (practical course, 3 SWS)		 Workload: 65 Hours work on project 45 Hours in-classroom work 10 Hours oral presentation and discussion (including preparation) 		
Contents of teaching: • Basics of electrical safety w • Safety in the lab. • Development, planning, cru • Independent realization of	ith focus on medical devices. eation and testing of an electrical circ a concrete project in a small team.	uit in the context of medical devices.		
Qualification-goals/Competencio • Students can plan, design, • Students gain experience in • Students know how to deli	es: specify and realize an electrical circuing n the area of project management. ver and present results in a timely material	t. Inner.		
Grading through: • presentation				
Requires: • Fundamentals of Electrical • Fundamentals of Electrical	Engineering 2 (ME2700-KP08, ME2700 Engineering 1 (ME2400-KP08, ME2400))))		
Responsible for this module: • Prof. Dr. Philipp Rostalski Teacher: • Institute for Electrical Engir	neering in Medicine			
Prof. Dr. Philipp Rostalski	5			
Literature: • U. Tietze, C. Schenk, E. Gam	ım: Halbleiter-Schaltungstechnik - ISB	N 978-3-642-31025-6		
Language: • offered only in German				
Notes: Admission requirements for t - Fundamentals of Electrical E	aking the module: ingineering 1 and 2 (ME2400 and ME:	2700)		
Admission requirements for participation in module examination(s): - Successful completion of the practical assignment and presentation.				
Module Exam(s): - ME3400-L1: Medical Electric	al Engineering Lab Course, completic	n of internship assignment and presentation, 100% of module grade.		



RO5300-KP06 - Humanoid Robotics (HumRob)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each summer semester		6	
 Course of study, specific field and term: Master Biophysics 2019 (optional subject), Elective, 1st or 2nd semester Bachelor Media Informatics 2020 (optional subject), Robotics and Autonomous Systems, 5th or 6th semester Bachelor Robotics and Autonomous Systems 2020 (optional subject), Robotics and Autonomous Systems, 5th or 6th semester Bachelor Medical Informatics 2019 (optional subject), medical computer science, 4th to 6th semester Bachelor Medical Informatics 2014 (optional subject), Robotics and Autonomous Systems, 5th or 6th semester Bachelor Media Informatics 2014 (optional subject), Robotics and Autonomous Systems, 5th or 6th semester Bachelor IT-Security 2016 (optional subject), Robotics and Autonomous Systems, Arbitrary semester Bachelor Robotics and Autonomous Systems 2016 (optional subject), Robotics and Autonomous Systems, 5th or 6th semester 				
Classes and lectures:		Workload:		
 Humanoid Robotics (lecture, 2 SWS) Humanoid Robotics (exercise, 2 SWS))	100 Hours private60 Hours in-class20 Hours exam private	e studies room work reparation	
 Contents of teaching: Development of humanoid robots: The special features of the kinematics of humanoid robots based on the human model are considered. Challenges and strategies for the design of humanoid robots are discussed. Mechatronic concepts for humanoid robot development are presented using examples. Control of humanoid walking robots: Basic concepts for the planning and control of walking movements are introduced. The characteristics of humanoid robot hands: Grip planning and grip synthesis with humanoid robot hands is presented. Basic characteristics of human grasping are considered. Analytical methods for planning and evaluating grasps are discussed and modern approaches for learning grasps are introduced. Modeling and planning: Basic concepts of modeling and planning tasks are discussed. The description of a goal-oriented action using 				
 Qualification-goals/Competencies: Students acquire the ability to independently solve application-oriented exercises from robotics, with a focus on (humanoid) robots with a mathematical background You have a basic understanding of the kinematic properties of humanoid robots They know the requirements for the design of humanoid robots and understand mechatronic concepts for the development of human-inspired robot kinematics. They understand the complexity of controlling humanoid robots, especially with regard to bipedal walking and gripping with five-fingered hands, including the dynamic processes You have gained an insight into learning methods for planning the action sequences of humanoid robots, including the dynamic processes 				
Grading through: Oral examination Responsible for this module:				
Prof. DrIng. Julia Starke				
Teacher: • Institute for Robotics and Cognitive Systems • Prof. DrIng. Julia Starke				
 Literature: Murray, Li and Sastry: A mathematical introduction to robotic manipulation - CRC Press 1994 				
Language:				



Notes:

Admission requirements for taking the module: - None

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

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Module Exam(s):

- RO5300-L1: Humanoid Robotics, oral exam, 100% of the module grade



RO5	401 - Seminar Robotics	and Navigation (SemRobNav)
Duration:	Turnus of offer:	Credit points:
1 Semester	each semester	4 (Тур В)
Course of study, specific field and terr • Bachelor Robotics and Autonom • Bachelor Robotics and Autonom	n: ous Systems 2020 (optional s ous Systems 2016 (optional sı	ubject), Robotics and Autonomous Systems, 5th or 6th semester ıbject), Robotics and Autonomous Systems, 5th or 6th semester
Classes and lectures: Workload: • Seminar Robotics and Navigation (seminar, 2 SWS) • 90 Hours work on an individual topic with presentation • 30 Hours in-classroom work		 Workload: 90 Hours work on an individual topic with written and oral presentation 30 Hours in-classroom work
Contents of teaching: • • • •		
Qualification-goals/Competencies: • • • • • •		
Grading through: • presentation		
Responsible for this module: • Prof. DrIng. Achim Schweikard Teacher: • Institute for Electrical Engineerin • Institute for Robotics and Cognit • Institute of Computer Engineerin • Prof. DrIng. Mladen Berekovic • Prof. DrIng. Achim Schweikard • Prof. Dr. Philipp Rostalski	g in Medicine ive Systems Ig	
Language: • German and English skills require	ed	
Notes: Admission requirements for taking - None Admission requirements for partici - None Module Exam(s): - RO5401-L1: Seminar Robotics and	the module: pation in module examination l Navigation, Seminar, 100% c	n(s): If module grade.



	i annas or orien.	Credit points.
Semester	each winter semester	8
		0
Course of study, specific field and Master CLS 2023 (compulsor) Bachelor Biophysics 2024 (co Bachelor Robotics and Auton Bachelor Computer Science 2 Bachelor Computer Science 2 Bachelor Mets 2020 (compuls Bachelor Media Informatics 2 Bachelor Medical Informatics 2 Bachelor Computer Science 2 Bachelor Robotics and Auton Bachelor IT-Security 2016 (co Bachelor Medical Informatics Bachelor Mets 2014 (compulsor)	term: y), mathematics, 1st semester mpulsory), computer science, 5th se nomous Systems 2020 (compulsory) 2019 (optional subject), major subject 2019 (compulsory), Canonical Specia ory), computer science, 5th semester 2020 (optional subject), computer sc 2019 (optional subject), computer sc 2014 (compulsory), specialization fie 2016 (compulsory), specialization fie 2016 (compulsory), canonical Specia 2016 (optional subject), major subject 2016 (compulsory), Canonical Specia 2016 (compulsory), Canonical Specia 2016 (compulsory), Canonical Specia 2016 (compulsory), Canonical Specia 2016 (compulsory), Canonical Specia y), mathematics, 1st semester nomous Systems 2016 (compulsory), ptional subject), computer science, A mpulsory), computer science, 5th semester 2014 (compulsory), computer science, 5th semester 2015 (compulsory), computer science, 5th semester 2016 (compulsory), computer scienc	emester , Robotics and Autonomous Systems, 5th semester ct informatics, Arbitrary semester lization Bioinformatics and Systems Biology, 5th semester r ience, 5th or 6th semester ccience, 4th to 6th semester ld robotics and automation, 5th semester ld bioinformatics, 5th semester lization Bioinformatics, 5th semester ct informatics, Arbitrary semester lization Web and Data Science, 5th semester rbitrary semester emester ce, 5th semester
Bachelor Media Informatics 2	014 (optional subject), computer sc	ience, 5th or 6th semester
Bachelor Computer Science 2	2014 (optional subject), central topic	s of computer science, 5th semester
Classes and lectures:		Workload:
• Signal Processing (lecture, 2	SWS)	110 Hours private studies
Signal Processing (exercise, 1	SWS)	90 Hours in-classroom work
 Image Processing (lecture, 2 Image Processing (exercise 1) 	SWS)	40 Hours exam preparation
Contents of teaching: Linear time-invariant system Impulse response Convolution Fourier transform Transfer function Correlation and energy dens Sampling Discrete-time signals and sys Discrete-time Fourier transfor FIR and IIR filters Block diagrams FIR filter design Discrete Fourier transform (FFT) Characterization and process Introduction, interest of visus 2D Sampling Image enhancement Edge detection Multiresolution concepts: Ga	s ity of deterministic signals tems rm DFT) sing of random signals al information ussian and Laplacian Pyramid, wave	lets



• Students work self-actingly and independently with regard to the roles of GSP of the University of Lübeck.
Qualification-goals/Competencies:
 Students are able to explain the fundamentals of linear system theory. They are able to define and competently explain the essential elements of signal processing mathematically. They will have a command of mathematical 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. They will have basic knowledge of two-dimensional system theory. They are able to describe the main techniques for image analysis and image enhancement. They are able to apply the learned principles in practice.
Grading through:
written exam
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 A. K. Jain: Fundamentals of Digital Image Processing - Prentice Hall, 1989 Rafael C. Gonzalez, Richard E. Woods: Digital Image Processing - Prentice Hall 2003
Language:
offered only in German
Notes:
Prerequisites for attending the module: - None
Prerequisites for the exam: - Successful completion of homework assignments during the semester (at least 50% of max. points).
Module exam: - CS3100-L1: Signal Processing, written exam, 90 min, 100% of module grade



CS3501-KP04, CS3501 - Lab Course Robotics and Automation (PraktRob)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each winter semester		4 (Тур В)	
Course of study, specific field and term: • Bachelor Robotics and Autonomous • Bachelor Robotics and Autonomous • Bachelor Computer Science 2014 (co • Bachelor Computer Science 2012 (co	Systems 2020 (compulsory Systems 2016 (compulsory) ompulsory), specialization fic ompulsory), specialization fic), Robotics and Autonomo), Robotics and Autonomot eld robotics and automatic eld robotics and automatic	us Systems, 5th semester us Systems, 5th semester on, 5th semester on, 5th semester	
Classes and lectures:		Workload:		
Lab Class Robotics and Automation	Lab Class Robotics and Automation (practical course, 3 SWS) Lab Class Robotics and Automation (practical course, 3 SWS) 45 Hours in-classroom work 45 Hours group work 30 Hours private studies			
 Contents of teaching: Combination of robotics and navigation Introduction to project management Realization of different robotic tasks in virtual and real environment Kinematics (direct and inverse) Implementation in the environments using sensor technology Human Potent Interaction 				
 Qualification-goals/Competencies: The students can realize different co They are able to implement the con The students are in a position to do 	oncepts of robot and naviga abination of robotics and na the project planning and re	tion system control and of vigation for simple tasks. alize it in teamwork accord	mobile robots in real life systems. Jing to predefined milestones.	
programming project				
Requires: • Robotics (CS2500-KP04, CS2500)				
Responsible for this module:				
Prof. DrIng. Achim Schweikard				
 Institute for Electrical Engineering ir Institute of Computer Engineering Institute for Robotics and Cognitive Prof. DrIng. Achim Schweikard Prof. DrIng. Mladen Berekovic 	n Medicine Systems			
 Prof. Dr. Philipp Rostalski DrIng. Kristian Ehlers 				
Literature: Jazar: Theory of applied Robotics: Ki Hertzberg et.al.: Mobile Roboter - Sp Siegert: Robotik: Programmierung in Siegwart et.al.: Autonomous Mobile	nematics, Dynamics and Co oringer 2012 ntelligenter Roboter Robots - MIT Press, 2011	ntrol		
Language: • offered only in German				
Notes:				



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



	ME3100-KP04, ME3100SJ14	4 - Medical Imaging (l	MBG14)
Duration:	Turnus of offer:		Credit points:
1 Semester	each winter semester		4
Course of study, specific field a • Bachelor Robotics and Au • Master Auditory Technolo • Master Auditory Technolo • Bachelor Robotics and Au • Bachelor Medical Informa • Bachelor Medical Informa	nd term: tonomous Systems 2020 (optional su gy 2022 (optional subject), Auditory gy 2017 (optional subject), Auditory tonomous Systems 2016 (optional su tics 2019 (optional subject), medical c tics 2014 (optional subject), medical c	ubject), Additionally recogn Technology, 1st semester Technology, 1st semester bject), medical image proc computer science, 4th to 6t	ized elective module, 5th semester essing, 5th or 6th semester h semester h semester
Classes and lectures:		Workload:	
 Medical Imaging (lecture, Medical Imaging (exercise 	2 SWS) ۶, 1 SWS)	55 Hours private45 Hours in-class20 Hours exam p	studies sroom work preparation
Contents of teaching: Introduction to the theory Ultrasound imaging Conventional X-ray imagi Magnetic Resonance Imag Qualification-goals/Competence The students can characte	y of imaging systems ng, Computed Tomography ging : ies: erise linear translation-invariant imagi	ing systems by means of in	npulse response and transfer function.
 They can describe what is They can give an overview They can explain the phy. They can describe the belee They can list the interdep They can list the interdep They can elucidate how the two two two two two two two two two two	meant by spatial resolution of an ima v of important medical imaging techn sical foundations of ultrasound imagin naviour of ultrasound waves at tissue amental limit to spatial resolution in U endence between ultrasound frequer echnical parameters are chosen for a realisation of beam forming in US im ppler US works. nportant US image artefacts occur. sical and technical foundations of X-ra al spectrum of a technical X-ray source the most important interaction proc e sources of hazard in X-ray imaging uence of technical parameters in X-ra stify important reconstruction princip sical foundations of nuclear magnetic patial resolution is achieved in NMR in rence of different types of radio frequ- cept of k-space. fferent weightings are achieved in MI azard in MRI and explain their causes. hnical components of an MR imaging portant algorithms used in imaging sys-	aging system. niques. ng. borders. US. ncy, spatial resolution, and given target to be imaged. aging. ay generation. re. esses between X-rays and i and discuss strategies for a ay imaging systems. les in CT and their mathem resonance (NMR). naging. uency echoes in NMR. R images. g system. stems.	penetration depth. matter. nvoiding them. natical foundations.
Responsible for this module: • Prof. Dr. rer. nat. Martin Ko Teacher:	och		



Institute of Medical Engineering	
Prof. Dr. rer. nat. Martin Koch	
 iterature: 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 	
 anguage: German and English skills required 	
lotes:	
Admission requirements for taking the module: - None	
Admission requirements for participation in module examination(s): - Successful completion of exercise assignments as specified at the beginning of the semester.	
Module Exam(s): - ME3100-L1: Medical Imaging, written exam, 60min, 100% of the module grade.	



RO3100-KP07	- Bachelor Project Robotics	and Autonomous Systems (BacProjRAS)		
Duration:	Turnus of offer:	Credit points:		
1 Semester	each winter semester	7 (Тур В)		
Course of study, specific field and t Bachelor Robotics and Autonc Bachelor Robotics and Autonc 	erm: omous Systems 2020 (compulsory omous Systems 2016 (compulsory)), Robotics and Autonomous Systems, 5th semester , Robotics and Autonomous Systems, 5th semester		
 Classes and lectures: Bachelor Project Robotics and Autonomous Systems (practical course, 5 SWS) 		 Workload: 120 Hours group work 45 Hours in-classroom work 15 Hours written report 10 Hours oral presentation (including preparation) 		
Contents of teaching: • Team-based planning and rea from requirement engineering	lization of a complete developme g to installation while observing st	nt project in the domain of robotics and autonomous systems ranging andards and deadlines.		
Qualification-goals/Competencies: In discussions with users, the They can analyse complex tas They can estimate the costs, p They can integrate component They can manage created arte	students can gather the requireme ks, structure them into subtasks, a lan the acitvities, and allocate the its into an overall application while facts, document implementations	ents for a system solution. nd implement them in team work ressources meeting the goals of the project e ensuring software quality s and present results		
Grading through: • successful addressing of the p	roject goals			
Responsible for this module: • Prof. Dr. Philipp Rostalski Teacher: • Institute of Computer Enginee • Institute for Robotics and Cog • Institute for Electrical Enginee • Alle prüfungsberechtigten De	ering nitive Systems ring in Medicine ozentinnen/Dozenten des Studien	iganges		
Literature: • Udo Lindemann: Methodische Springer, 2009	e Entwicklung technischer Produkt	e: Methoden flexibel und situationsgerecht anwenden (VDI-Buch) -		
Language: • offered only in German				
Notes: Admission requirements for taki - None Admission requirements for part - Successful completion of the ir - Documentation and (possibly i Module examination(s): - RO3100-L1: Bachelor Project Ro module grade.	ng the module: ticipation in module examination(nternship assignment nterim) presentation as specified v obotics and Autonomous Systems,	s): when the internship is issued. , internship performance and documentation and presentation, 100% of		



CS3050-KP04, CS3050 - Coding and Security (CodeSich)			
Duration:	Turnus of offer:		Credit points:
1 Semester	each summer semester		4
Course of study, specific field Bachelor Computer Sci Bachelor Computer Sci Bachelor Computer Sci Bachelor Media Inform Bachelor Robotics and Bachelor Medical Inform Bachelor Computer Sci Bachelor Computer Sci Bachelor Computer Sci Bachelor Computer Sci Bachelor Robotics and Bachelor Robotics and Bachelor IT-Security 20 Bachelor Medical Inform Master CLS 2010 (option	d and term: ence 2019 (optional subject), major sub ence 2019 (compulsory), Canonical Spe ence 2019 (optional subject), Canonical atics 2020 (optional subject), computer Autonomous Systems 2020 (optional s natics 2019 (optional subject), compute ence 2016 (optional subject), major sub ence 2016 (optional subject), Canonical ence 2016 (optional subject), Canonical ence 2016 (optional subject), Canonical sutonomous Systems 2016 (optional sub ence 2016 (optional subject), Canonical fl (compulsory), IT-Security, 4th semes matics 2014 (optional subject), computer atics 2014 (optional subject), computer nal suject), computer science, Arbitrary	oject informatics, Arbitrary s ecialization Web and Data So I Specialization SSE, 2nd ser science, 5th or 6th semeste subject), computer science, 4 er science, 4th to 6th semes oject informatics, Arbitrary s I Specialization Web and Da I Specialization SSE, 2nd ser ubject), computer science, 6 ter er science, 5th or 6th semester science, 5th or 6th semester semester	eemester cience, 2nd semester nester er 6th semester iter eemester nata Science, 2nd semester nester 5th semester 5th semester
Classes and lectures:		Workload:	
 Coding and Security (le Coding and Security (e 	ecture, 2 SWS) xercise, 1 SWS)	65 Hours private45 Hours in-class10 Hours example	e studies and exercises sroom work preparation
 information, entropie discrete sources and ch coding systems, error-t codes for digital media threats to IT-systems formal definition of sec security primitives Qualification-goals/Compete The students can explai They can explain the co They are able to model They know the most in They know basic scena 	nannels olerant codes , compression curity properties encies: in and apply the basics of information oncept of information. I information sources and communicati nportant codes and are familiar with th rios of attacks and protection methods	and coding theory ion networks. eir specific design principle:	s and properties.
Grading through: • written exam			
Requires: • Linear Algebra and Dise	crete Structures 1 (MA1000-KP08, MA10	000)	
Responsible for this module: • Prof. Dr. Rüdiger Reisch Teacher: • Institute for Theoretica • Prof. Dr. Rüdiger Reisch • Prof. Dr. Maciej Liskiew	nuk I Computer Science nuk icz		
Literature: • D. Hoffmann: Einführu	ng in die Informations- und Codierungs	stheorie - Springer Vieweg 2	2014



- D. Salomon: Coding for Data and Computer Communications Springer 2005
- D. Salomon: Data Privacy and Security Springer 2003
- M. Stamp: Information Security: Principles and Practice Wiley 2006
- R. Roth: Introduction to Coding Theory Cambridge Univ. Press 2006

Language:

German and English skills required

Notes:

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





	CS3140-KP04 - Cloud and Web Technologies (WebTech)			
Duration:	Turnus of offer:		Credit points:	
1 Semester	er each summer semester		4	
Course of study, specific field an Bachelor Robotics and Aut Bachelor Computer Science Bachelor Computer Science Bachelor Computer Science Bachelor Computer Science Bachelor Medical Informati Bachelor IT-Security 2016 (d term: onomous Systems 2020 (optiona e 2014 (optional subject), major s e 2016 (optional subject), major s e 2019 (optional subject), major s e 2019 (compulsory), Canonical S cs 2019 (optional subject), compu optional subject), specific, Arbitra	l subject), Additionally recog ubject informatics, Arbitrary s ubject informatics, Arbitrary s ubject informatics, Arbitrary s pecialization Web and Data S uter science, 4th to 6th semes ry semester	nized elective module, 6th semester semester semester semester science, 6th semester ster	
Classes and lectures:		Workload:		
 Cloud and Web Technolog Cloud and Web Technolog 	 Cloud and Web Technologies (lecture, 2 SWS) Cloud and Web Technologies (exercise, 2 SWS) Cloud and Web Technologies (exercise, 2 SWS) 40 Hours private studies 20 Hours exam preparation 		ssroom work e studies preparation	
 Web-technologies and wei Client and server technolo Cloud Computing Architectures und middlev Web protocols Document languages Semantic Web 	b-engineering gies vare-technologies			
 Qualification-goals/Competenci Students can analyze prob solution. They are able to explain th They can model knowledg They can store, administer They can judge for which participation 	es: lems of websites, evaluate with w e division of work between serve e bases with the help of Semantic and process big data in the cloud problems Semantic Web technolo	which web technologies they rs and clients in the web. Web technologies. I. gies are promising compared	can be solved and implement the envisioned d to traditional approaches.	
Grading through:				
Written or oral exam as an	nounced by the examiner			
Responsible for this module:				
Prof. Dr. Sven Groppe Teacher:				
Institute of Information System	stems			
Prof. Dr. Sven Groppe				
Literature: • R. W. Sebesta: Programmir • J. Domingue, D. Fensel, J.A • R. Wartala: Hadoop: Zuverl • S. Groppe: Data Managem	ig the World Wide Web - Pearson . Hendler (Eds.): Handbook of Sen ässige, verteilte und skalierbare B ent and Query Processing in Sema	New International Edition - F nantic Web Technologies ig-Data-Anwendungen - Ope antic Web Databases - Spring	Pearson, 2014 en Source Press, 2012 jer, 2011	
Language: • German and English skills r	equired			
Notes:				



Prerequisites for attending the module: - None

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



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 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 (optional subject), major subject informatics, Arbitrary 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 Bachelor Biophysics 2016 (optional subject), computer science, 4th to 6th semester Bachelor Bachelor Biophysics 2014 (optional subject), computer science, 5th or 6th semester Bachelor Media Informatics 2014 (optional subject), computer science, 5th or 6th semester Bachelor Media Informatics 2014 (optional subject), computer science, 5th or 6th semester Bachelor Media Informatics 2014 (optional subject), computer science, 6th semester Bachelor Computer Science 2014 (compulsory), specialization field robotics and automation, 6th semester Bachelor Computer Science 2014 (compulsory), specialization field robotics and automation, 6th semester Bachelor Medica Informatics 2011 (optional subject), computer science, 6th se			
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	ce (lecture, 2 SWS) ce (exercise, 2 SWS)	55 Hours private45 Hours in-clas20 Hours exam (e studies sroom work 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)





ME3300-KP04, ME3300 - Measurement Technology (MTech)				
Duration:	Turnus of offer:		Credit points:	
1 Semester	each summer semester		4	
 Course of study, specific field and term: Bachelor MES 2020 (optional subject), computer science / electrical engineering, 3rd semester at the earliest Bachelor IT-Security 2016 (optional subject), mathematics, Arbitrary semester Bachelor Robotics and Autonomous Systems 2016 (optional subject), electrical engineering, 6th semester Bachelor MES 2014 (optional subject), computer science / electrical engineering, 4th or 6th semester Bachelor Robotics and Autonomous Systems 2020 (optional subject), Additionally recognized elective module, 6th semester 				
Classes and lectures:		Workload:		
 Measurement Technology (lecture, 2 Measurement Technology (exercise, Measurement Technology (project v 	 Measurement Technology (lecture, 2 SWS) Measurement Technology (exercise, 0,5 SWS) Measurement Technology (project work, 0,5 SWS) Measurement Technology (project work, 0,5 SWS) 10 Hours oral presentation and discussion (including preparation) 		n project room work reparation ssentation and discussion (including	
Contents of teaching:				
 Measuring systems and measuring errors Application areas of measurement technology: temperature sensors, displacement and velocity measurement, electrical potential measurement, biosignal measurement, capacitance measurement, impedance measurement, humidity measurement, concentration measurements Electrotechnical measuring circuits Non-ideal amplifiers and filter circuits Probability theory Measurement of stochastic signals Description of measured signals Acquisition of analog signals Practical measurement data acquisition Requirements of medical technology for measurement technology Observation of non-measurable conditions 				
Qualification-goals/Competencies:				
 The students know the elements of The students are able to describe ar They are able to design and charact The students are familiar with essen mechatronics. The students know the essential cor 	the measurement chain in c id evaluate requirements fo erize basic electrical measur tial measuring instruments inections between measuri	detail, how they can be cha r measurement technology rement circuits. and methods, especially w ng element and control loc	aracterized and their possible characteristics. y. ith a focus on medical metrology and op.	
Grading through:				
Written or oral exam as announced by the examiner				
 Fundamentals of Electrical Engineering 1 (ME2400-KP08, ME2400) 				
Responsible for this module:				
Prof. Dr. Georg Schildbach				
Teacher:	Modicino			
Prof Dr Georg Schildbach	medicine			
Literature:				
 Lerch: Elektrische Messtechnik: Analoge, digitale und computergestutzte Verfahren - 6. Auflage, Springer Verlag 2012 Schrüfer, Reindl, Zagar: Elektrische Messtechnik: Messung elektrischer und nichtelektrischer Größen - 11. Auflage, Carl Hanser Verlag 				



2014

• Parthier: Messtechnik: Grundlagen und Anwendungen der elektrischen Messtechnik - 8. Auflage, Springer Vieweg Verlag 2016

- Webster: Medical Instrumentation: Application and Design 4th edition, John Wiley & Sons 2010
-

Language:

• German and English skills required

Notes:

currently suspended



RO3990	-KP15 - Bachelor Thesis Roboti	cs and Autonomous	Systems (BScRAS)
Duration:	Turnus of offer:		Credit points:
1 Semester	Semester each semester		15
Course of study, specific field a • Bachelor Robotics and Au • Bachelor Robotics and Au	n d term: Itonomous Systems 2020 (compulsory) Itonomous Systems 2016 (compulsory),), Robotics and Autonomo , Robotics and Autonomo	us Systems, 6th semester us Systems, 6th semester
 Classes and lectures: Bachelor Thesis Robotics and Autonomous Systems (supervised self studies, 1 SWS) Colloquium (presentation (incl. preparation), 1 SWS) 		 Workload: 360 Hours research for and write up of a thesis 90 Hours oral presentation and discussion (including preparation) 	
Contents of teaching: • investigating a given pro • colloquium to represent	blem in robotics and autonomous syste the results including a discussion with t	ems or application areas a he referees	nd developing a good solution
Qualification-goals/Competent Students are able to solve They have the expertise t They can present comple They are experts for a cle	c ies: e a limited task of a scientific problem v o plan, organize and carry out a project x information in written and oral form. arly defined topic.	vith the means of their dis t work.	scipline.
Grading through: • Written report			
Responsible for this module: Studiengangsleitung Ro Teacher: Institutes of the Departm Alle prüfungsberechtigt 	botik und Autonome Systeme ent of Computer Science/ Engineering en Dozentinnen/Dozenten des Studien	ganges	
Literature: • depends on subject:			
Language: • thesis can be written in G	erman or English		
Notes: Admission requirements for - See study program regula Admission requirements for - see study program regulat Module Exam(s): - RO3990-L1: Bachelor Thes	r taking the module: tions (e.g. certain minimum CP achiever r participation in module examination(s tions is Robotics and Autonomous Systems, f	d). s): final paper, 100% of modu	ıle grade.





RO4400-KP08 - Control Systems (RegelSys)			
Duration:	Turnus of offer:		Credit points:
1 Semester	every summer semester		8
Course of study, specific field and term: • Master MES 2020 (optional subject), computer science / electrical engineering, Arbitrary semester • Bachelor Robotics and Autonomous Systems 2020 (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 • Classes and lectures: • Morkload: • Control Systems (lecture, 2 SWS) • 110 Hours private studies • Advanced Methods in Control (lecture, 2 SWS) • 90 Hours in-classroom work • 40 Hours exam preparation			
 Control Systems (exercise, 1 SWS) Advanced Methods in Control (exercise, 1 SWS) 40 Hours exam preparation 41 Hours exam preparation 42 Hours exam preparation 43 Hours exam preparation 44 Hours exam			
Grading through: • written exam			
Responsible for this module: • Prof. Dr. Philipp Rostalski Teacher: • Institute for Electrical Engineering • Prof. Dr. Philipp Rostalski • Prof. DrIng. Christian Herzog Literature:	g in Medicine		
• as described for the module part Language:	5:		
5 5			



German and English skills required

Notes:

This module replaces ME2450-KP08

Admission requirements for taking the module: - None

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

Module Exam(s):

- RO4400-L1: Control Systems, written exam, 90min, 100% of module grade.



CS2101-KP04, CS2101 - Embedded Systems (ES)			
Duration:	Turnus of offer:		Credit points:
1 Semester	each summer semester		4
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 MES 2020 (optional subject), computer science / electrical engineering, 3rd semester at the earliest Bachelor Metical Informatics 2019 (optional subject), computer science, 4th to 6th semester Bachelor Computer Science 2016 (optional subject), canonical Specialization SSE, 6th semester Bachelor Medical Informatics 2019 (optional subject), computer science, 4th to 6th semester Bachelor Computer Science 2016 (optional subject), Canonical Specialization SSE, 6th semester Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th of 6th semester Bachelor Computer Science 2016 (optional subject), Canonical Specialization SSE, 6th semester Bachelor Robotics and Autonomous Systems 2016 (optional subject), computer science, 5th of 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, 6th semester Bachelor Medical Informatics 2014 (optional subject), computer			
Bachelor Biophysics 2024 (optional su	ubject), computer science,	6th semester	
Classes and lectures: • Embedded Systems (lecture, 2 SWS) • Embedded Systems (exercise, 1 SWS)	Classes and lectures:Workload:• 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		
Contents of teaching: • Target architectures (microcontrollers, FPGAs etc.) • Conceptional models • Peripheral buses • Scheduling algorithms and real-time operating systems • 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



RO5005-KP01 - Participation in a Robot Challenge (RobCha)			
Duration:	Turnus of offer:		Credit points:
1 Semester	irregularly		1
Course of study, specific field an • Bachelor Robotics and Auto	id term: onomous Systems 2020 (optional sul	oject), Additionally recogn	ized elective module, Arbitrary semester
 Classes and lectures: RO5005-P: Participation in a Robot Challenge (practical course, 1 SWS) 		Workload: • 15 Hours work on project • 15 Hours in-classroom work	
Contents of teaching: • Construction and program	ming of a robot with the aim of parti	cipating in a robot challen	ge.
Qualification-goals/Competencie • tudents have an understan	es: Iding of the design of a robot for a sp	ecific application scenario	
Grading through: • continuous, successful part	cicipation in practical course		
Responsible for this module: • Prof. Dr. Philipp Rostalski Teacher: • Institute of Computer Engin • Institute for Electrical Engir • Institute for Robotics and C • DrIng. Kristian Ehlers	neering neering in Medicine Cognitive Systems		
Language: • German or English			
Notes: Admission requirements for t - none Admission requirements for p - Successful participation in t Module examination(s): - RO5005-L1: Participation in	taking the module: participation in module examination(he robot challenge a robot challenge, practical course, 1	s): 00% of the module grade	
To take this module, contact	the lecturer in advance.		