Modulhandbuch

Embedded Systems and Microrobotics - Master's Programme

im Wintersemester 2021/2022

erstellt am 19/10/21

Kernmodule

inf900 - Group Project

Module label	Group Project
Module code	inf900
Credit points	24.0 KP
Workload	720 h
Applicability of the module	• Master's Programme Business Informatics (Master) > Kernmodule • Master's Programme Computing Science (Master) > Kernmodule • Master's Programme Embedded Systems and Microrobotics (Master) > Kernmodule • Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering
Responsible persons	Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	The students get familiar with different software development aspects in a team. Apart from software engineering knowledge and skills they develop key competences like project management, teamwork, problem solving competence and conflict management. Additionally, students develop special knowledge, skills and competences from the project group topic. **Professional competence** The students: • characterise and apply computer science basics (algorithms, data structures, programming, basics of practical, technical and theoretical computer science) • define und describe essential mathematical, logical and physical basics of computer science • define and illustrate the core disciplines of computer science (theoratical, practical and technical computer science) **Methodological competence** The students: • examine problems, use formal methods to phrase and analyze them appropriately • evaluate problems by the use of technical and scientific literature • reflect on a scientific topic and write a scientific seminar paper under guidance and present their findings **Social competence** The students: • integrate criticism into their own actions • respect team decisions • communicate with users and experts convincingly **Self-competence** The students: • take on project management tasks • pursue the overall and special computer science development critically • implement innovative professional activities effectively and independently • recognise their abilities and extend them purposefully • reflect their self-perception and actions with regard to professional, methodological and social aspects • develop and reflect self-developed hypotheses to theories independently • work in their field independently
Module contents	Cooperative development of a large-scale computer science project. This project general includes the (further) development of a hard or software system.
Reader's advisory	According to the assigned task
Links	https://www.uni-oldenburg.de/informatik/studium-lehre/infos-zum-studium/projektgruppen-im-masterstudium/
Languages of instruction	German, English
Duration (semesters)	2 Semester

Module frequency	semi-anual	
Module capacity	unlimited	
Reference text	Dieses Modul ist im Rahmen der Projekte FliF und FoL konzipiert worden	
Modullevel / module level	AS (Akzentsetzung / Accentuation)	
Modulart / typ of module	Pflicht o. Wahlpflicht / compulsory or optioal	
Lehr-/Lernform / Teaching/Learning method	PG	
Vorkenntnisse / Previous knowledge	- Programmierkurs - Softwaretechnik - Soft Skills	
Examination	Time of examination	Type of examination
Final exam of module	Im Stud.IP nach Bekanntgabe der einzelnen Gruppen und Themen	Active involvement, presentation, final report, project assessment
Course type	Project group	
SWS	8	
Frequency	SoSe und WiSe	
Workload attendance	112 h	

Akzentsetzungsmodule

inf100 - Human Computer Interaction

Module label	Human Computer Interaction
Module code	inf100
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik • Master's Programme Computing Science (Master) > Praktische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule • Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction • Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
Responsible persons	Boll-Westermann, Susanne (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	With the help of suitable resources, the students can design, prototype, and evaluate a human-machine interface following the user-centered design process (HCD). **Professional competence** The students: - can describe and explain the HCD process. - can classify an unknown method into the HCD process when they are presented with a brief description. - can select a suitable prototyping approach for a given application. - can select a suitable prototyping method for a given application. - can apply selected prototyping methods to create an interactive system - can name basic characteristics of human perception and motor skills and explain their importance for the development of interactive systems. - can suggest and motivate improvement for a given user interface based on the gestalt laws. -can explain the characteristics of human visual search and utilize it to improve given interfaces. - can critically compare several variants of an interactive system’s concept based on the "Multiple Resource Theory". **Methoden competence** The students: - can critically compare and select methods for context of use and/or user requirements analysis. - can apply methods for context of use and/or user requirements analysis to a real-world example. - can retrospectively discuss and evaluate the use of a method for context of use and/or user requirements analysis. - can plan, moderate and evaluate an ideation session. - can formulate a precise research question based on a given problem description. - can discuss the advantages and disadvantages of an experiment design. - can select a suitable experiment design for a given research question. - can define hypotheses and null hypotheses for a given experiment. **Social competence ** The students: - can work out solutions for a given design problem in group work. - can present solutions to design problem in the plenum. - can motivate their methodical approach to a design problem. - can discuss their designs and results in an appropriate and professional manner with the plenum. - can accept criticisms by their peer group as valuable contributions to their designs.
Module contents	The module covers research methods in the field of human-computer interaction. It discusses the core principles of human-computer interaction and the human-centered design process and its phases, context of use, requirements, and task analysis, prototyping and evaluation. Research methods used in the different phases of the process are introduced and discussed. Available design options for human-machine interfaces are presented and discussed with regard to human perception capabilities and their limitations. The module discusses methods for user research, including surveys, diaries, case studies, interviews, and focus groups, as well as physiological measurements. The module goes into further detail on evaluation methods, and introduces the foundations of experimental research in human-computer interaction, including types of research, research hypotheses, experimental design, and statistical analysis. During the practical project, a concrete human-computer interface will be designed, developed and evaluated.

Reader's advisory	- Alan Dix, Jane Finlay, Gegory Abowd, Russel Beale, Human Computer Interaction Person, 2004. - Markus Dahm, Grundlagen der Mensch Computer-Interaktion. Pearson, 2006 - Literature in the reserve shelf in the university bibliography. Link list in Stud.IP.
Links	medien.informatik.uni-oldenburg.de/lehre
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	once a year
Module capacity	unlimited
Reference text	Useful previus knowledge: Interactive Systems
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	
Lehr-/Lernform / Teaching/Learning method	V+P
Vorkenntnisse / Previous knowledge	Grundkenntnisse Programmierung

Examination	Time of examination	Type of examination
Final exam of module	The completed practical projects will be presented on a single project day, which will take place at the end of the lecture period. The oral exam takes place within the last two weeks of the lecture period. If necessary, re-examinations will take place at the end of the term. Details on the schedule can be found on the websites of the department and in Stud.IP.	Practical group project which progress has to be presented regularly during the tutorials. Oral exam on the topics of the lecture. Practical project and oral exam count 50% each to the final grade. Both practical project and oral exam have to be passed individually.

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		2	SuSe	28
Tutorial		2	SuSe	28
Total time of attendance for the module				56 h

inf105 - Fault Tolerance in Distributed Systems

Module label	Fault Tolerance in Distributed Systems
Module code	inf105
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Praktische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Lehrenden, Die im Modul (Module counselling) Theel, Oliver (Module responsibility) Modulverantwortlichen, Die (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	This module provides knowledge of fault-tolerant distributed systems. The terminology, structure, conception, core challenges and related implementation concepts will be covered in detail. Professional competence The students: • Assess what a fault-tolerant distributed system is and develop awareness of its capabilities • Name and discuss common implementations of fault-tolerant distributed systems Methodological competence The students: • Reflect the implementation challenges of a distributed system • Are able to adapt and evolve implementation concepts of fault-tolerant distributed systems in new contexts Social competence The students: • Solve problems in small teams • Present their solutions to the members of the tutorial • Discuss their different solutions with members of the tutorial Self-competence The students: • Accept criticism • Question their initially applied methods for problem solving • Question their initial solutions in the light of newly learned methods
Module contents	1) Fault, Error, Failure 2) Failure semantics, Fault tolerance 3) Byzantine agreement protocols 4) Stable storage 5) Fail-stop processors 6) Atomic commit protocols 7) Classification of replication control schemes • pessimistic vs. optimistic • semantic vs. syntactic • static vs. dynamic 8) Consistency notions 9) Quality criteria 10) Survey of replication control schemes 11) Design of replication control schemes 12) Unifying frameworks 13) Replication in practice
Reader's advisory	P. Jalote (1994): Fault Tolerance in Distributed Systems. Prentice-Hall. A. Helal et. Al (1996): Replication Techniques in Distributed Systems. Kluwer Academics A. Schiper et. Al (2010): Replication: Theory and Practice

Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	jährlich
Module capacity	unlimited
Reference text	connectet with: Betriebssysteme 1 und 2 Betriebssysteme-Praktikum Verteilte Betriebssysteme
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	Wahlpflicht / Elective
Lehr-/Lernform / Teaching/Learning method	V+S bzw V+Ü
Vorkenntnisse / Previous knowledge	Verteilte Betriebssysteme

Examination	Time of examination	Type of examination
Final exam of module	End of lecture period	written exam or oral exam or practical work

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		2	WiSe	28
Seminar or exercise		2	WiSe	28
Total time of attendance for the module				56 h

inf300 - Hybrid Systems

Module label	Hybrid Systems
Module code	inf300
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Computing Science (Master) > Theoretische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule • Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction • Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering
Responsible persons	Fränzle, Martin Georg (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	Kenntnisse aus dem BSc.-Studiengang Informatik mit Vertiefungsrichtung "Eingebettete Systeme und Mikrorobotik" bzw. entsprechende Kenntnisse aus den Angleichungsmodulen des MSc.-Studiengangs.Begründung: Die Vorlesung setzt Kenntnisse der Modellierung and Analyse reaktiver Systeme voraus.
Skills to be acquired in this module	The module gives an introduction to hybrid discrete-continuous systems, as arising by embedding digital hardware into physical environments, and it elaborates on state of the art methods for the mathematical modelling and the analysis of such systems. It thus provides central competences for understanding and designing reliable cyber-physical systems. **Professional competence** The students: • characterise formal models of cyber-physical systems: hybrid automata, hybrid state transition systems • name domain-specific system requirements: safety, stability, robustness • name analysis methods: symbolic state-space exploration, abstraction and abstraction refinement, generalized Lyapunov-Methods • use state-of-the-art analysis tools • select and apply adequate modelling and analysis methods for concrete application scenarios • apply methods to reduce large state spaces and reduce infinite-state systems by abstraction • know the de-facto industry standards for system modelling and are able to apply the corresponding modelling framewortks and tools **Methodological competence** The students: • mtdel heterogeneous dynamical systems with adequate modelling and design tools, in particular Simulink/Stateflow • transfer modelling and analysis methods to other heterogeneous domains, e.g. socio-technical systems **Social competence** The students: • work in teams • solve complex modelling, design, and analysis tasks in teams **Self-competence** The students: • reflect their actions and respect the scope of methods dedicated to hybrid systems
Module contents	Embedded computer systems continuously interact with their environment, which generally comprises state- and time-continuous components.The coupling of the embedded system to its environment thus induces complex interleavings between discrete computational and decision processes and continuous processes. The resulting processes are neither amenable to the analytic techniques of continuous control nor of discrete mathematics. They instead require a broader, integrated theory: hybrid discrete-continuous systems.The lectures provide an in-depth introduction into a variety of analysis and design methods of these computer-based systems and their recent extensions to cyber-physical systems The accompanying hands-on-project enhances the lecture by developing and using design and verification tools.
Reader's advisory	

- Luca P Carloni, Roberto Passerone, Allesandro Pinto & Alberto L Sangiovanni-Vincentelli: Languages and Tools for Hybrid System design.World Scientific, 2006.
- Wassim M. Haddad, VijaySekhar Chellaboina & Sergey G. Nersesov: Impulsive and Hybrid Dynamical Systems: Stability, Dissipativity, and Control. Princeton University Press, 2006
- Daniel Liberzon: Switching in Systems and Control. Birkhauser, 2003
- Michael Huth, Mark Ryan: Logic in Computer Science: Modelling and Reasoning About Systems. Cambridge University Press, 2004.
- Christel Baier, Joost-Pieter Katoen: Principles of Model Checking. MIT Press, 2008.

Links	
Languages of instruction	English , German
Duration (semesters)	1 Semester
Module frequency	once a year
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	Pflicht o. Wahlpflicht / compulsory or optioal
Lehr-/Lernform / Teaching/Learning method	V+Ü
Vorkenntnisse / Previous knowledge	Bachelor in Computing Science oder Kenntnisse gewöhnlicher Differentialgleichungen

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture period	Semester project including written work and final presentation

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	SuSe	42
Exercises		1	SuSe	14
Total time of attendance for the module				56 h

inf301 - Machine-oriented Systems Engineering

Module label	Machine-oriented Systems Engineering
Module code	inf301
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule • Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction • Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction • Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering
Responsible persons	Mikschl, Alfred (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	The module provides practical relevance to the design of digital embedded systems. **Professional competence** The students: • characterise the structure of microprocessor systems • name control aspects of time sensitive external components • program efficient embedded systems **Methodological competence** The students: • use specifications from electrical components data sheets **Social competence** The students: • work in a team • discuss solutions
Module contents	Embedded systems support complex feedback problems, control problems and data processing tasks. They have an important value creation potential for telecommunications, production management, transport and electronics. The functionality of embedded systems is realised by the integration of processors, special hardware and software. The embedded systems design is influenced by the heterogeneity of system architectures, the complexity of systems and technical and economic requirements. This module gives an initial review of computer architectures. After that embedded systems are introduced by a specific microprocessor. Furthermore, external hardware will be connected to the microprocessor. Besides this, the design of circuit boards will be discussed. The students will design, develop and implement a circuit layout with CAD and programme this embedded system with a Flash-eprom.
Reader's advisory	Lecturers notes, hardware manuals and data sheets, and development tool manuals
Links	
Languages of instruction	English , German
Duration (semesters)	1 Semester
Module frequency	semi-anual
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	Pflicht o. Wahlpflicht / compulsory or optioal
Lehr-/Lernform / Teaching/Learning method	V+P
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture period	Portfolio (Design, development and implementation of embedded systems, colloquium)

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		2	WiSe	28
Practical training		2	WiSe	28
Total time of attendance for the module				56 h

inf303 - Fuzzy Control and Artificial Neural Networks in Robotics and Automation

Module label	Fuzzy Control and Artificial Neural Networks in Robotics and Automation
Module code	inf303
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Angewandte Informatik • Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule • Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction • Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction • Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering • Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies
Responsible persons	Fatikow, Sergej (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	Experts in different branches try to approach their application-specific control and information processing problems by using fuzzy logic and artificial neural networks (ANN). The experiences gathered up to now prove robotics and automation technology to be predestined fields of application of both these approaches. The major topics of the course are control problems in robotics and automation technology, principles of fuzzy logic and ANN and their practical appplications, comparison of conventional and advanced control methods, combination of fuzzy logic and ANN in control systems. The course gives a comprehensive treatment of these advanced approaches for interested students. **Professional competence** The students: • recognise control problems in robotics and automation technology, • name principles of fuzzy logic and ANN and their practical appplications, • compare conventional and advanced control methods, • characterise the combination of fuzzy logic and ANN in control systems **Methodological competence** The students: • will acquire knowledge of the tools, methods and applications in fuzzy logic and ANN • deepen their knowledge for the practical use of the given methods • can use common software tools for design and application of fuzzy logic and ANN **Social competence** The students: • gain experience in interdisciplinary work • are integrated into the recent research work Objective of the module / skills: **Self-competence** The students: • are able to transfer the gained knowledge for later use in their theses or studies for AMiR • can Design (complex) fuzzy logic controller and ANN systems • reflect their (control) solutions by using methods learned in this course
Module contents	• Control problems in robotics and automation technology • Basic ideas of fuzzy logic and ANN • Principles of fuzzy logic • Fuzzy logic of rule-based systems • ANN models • ANN learning rules • Multilayer perceptron networks and backpropagation

- Associative networks
- Self-organizing feature maps
- PID design principles
- Design of fuzzy control systems
- Fuzzy logic application examples
- Design of ANN control systems
- ANN application examples
- Fuzzy + Neuro: principles and applications

Reader's advisory

Essential:

- Lecture notes (available at the secretariat, A1-3-303) in book form

Recommended:

- Bothe, H.-H.: Neuro-Fuzzy-Methoden, Springer, 1998
- Braun, Feulner, Malaka: Praktikum Neuronale Netze, Springer, 1997
- Kahlert, J.: Fuzzy Control für Ingenieure, Vieweg, Braunschweig Wiesbaden, 1995
- Nauck, D., Klawonn, F. und Kruse, R.: Neuronale Netze und Fuzzy-Systeme, Vieweg, 1994
- Zell, A.: Simulation Neuronaler Netze, Addison-Wesley / Oldenbourg Verlag, Bonn, 1996

Secondary Literature:

- Altrock, M. O. R.: Fuzzy Logic, R. Oldenbourg Verlag, 1993
- Bekey, A. and Goldberg, K.Y. (Eds.): Neural Networks in Robotics, Kluwer Academic, 1996
- Berns, K. und Kolb, T.: Neuronale Netze für technische Anwendungen, Springer, 1994
- Bothe, H.-H.: Fuzzy Logic, Springer, 1993
- Bunke, H., Kandel, A. (eds.): Neuro-Fuzzy Pattern Recognition, World Scientific Publ., 2000
- Kahlert, J. und Hubert, F.: Fuzzy-Logik und Fuzzy-Control, Vieweg, 1993
- Kim, Y.H. and Lewis, F.L.: High-Level Feedback Control with Neural Networks, World Scientific, 1998
- Kratzer, K.P.: Neuronale Netze, Carl Hanser, 1993
- Lämmel, U. und Cleve, J.: Künstliche Intelligenz (neuronale Netze), Fachbuchverlag Leipzig, 2001
- Lawrence, J.: Neuronale Netze, Systhema Verlag, München, 1992
- Omidvar, O. and van der Smagt, P. (eds.): Neural Networks for Robotics, Academic Press, 1997
- Patterson, D.W.: Künstliche neuronale Netze, Prentice Hall, 1996
- Pham, D.T. a200
- nd Liu, X.: Neural Networks for Identification, Prediction and Control, Springer, 1997
- Rigoll, G.: Neuronale Netze, Expert Verlag, Renningen-Malmsheim, 1994
- Ritter, H., Martinetz, Th. und Schulten, K.: Neuronale Netze, Addison-Wesley, 1991
- Schulte, U.: Einführung in Fuzzy-Logik, Franzis-Verlag, München, 1993
- Tizhoosh, H.R.: Fuzzy-Bildverarbeitung, Springer, 1998
- von Altrock, C.: Fuzzy Logic: Technologie, Oldenbourg, 1993
- White, D. and Sofge, D. (Eds.): Handbook of Intelligent Control, Van Nostrand Reinhold, New York, 1992
- Zakharian, S. Ladewig-Riebler, P. und Thoer, St.: Neuronale Netze für Ingenieure, Vieweg, Wiesbaden, 1998
- Zalzala, A. and Morris, A. (Eds.): Neural Networks for Robotic Control, Ellis Horwood, London, 1996
- Zimmermann H.-J. (Hrsg.): Datenanalyse, VDI-Verlag, 1995
- Zimmermann, H.-J. (Hrsg.): Neuro + Fuzzy: Technologien und Anwendungen, VDI-Verlag, 1995
- Zimmermann, H.-J. und von Altrock, C. (Hrsg.): Fuzzy Logic: Anwendungen, Oldenbourg, 1994

Links	
Languages of instruction	English , German
Duration (semesters)	1 Semester
Module frequency	once a year
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	Pflicht o. Wahlpflicht / compulsory or optioal
Lehr-/Lernform / Teaching/Learning method	V+Ü
Vorkenntnisse / Previous knowledge	Regelungstechnik

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture period until the beginning of the next semester	Hands-on-exercises and oral Exam

Course type	Comment	SWS	Frequency	Workload of compulsory attendance

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	SuSe	42
Exercises		1	SuSe	14
Total time of attendance for the module				56 h

inf305 - Medical Technology

Module label	Medical Technology
Module code	inf305
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Nicht Informatik • Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule • Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction • Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction • Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering
Responsible persons	Hein, Andreas (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	**Professional competence** The students: • Describe medical diagnosis and therapy methods • Understand the core concepts of computer-assisted medical interventions • Are aware of the basic concepts and legal conditions of the development of medical devices • Define the character of medical devices' software parts and implement them • Assess the complex interaction of medical products and patients • Get familiar with the development of medical products within a short period of time **Methodological competence** The students: • Recognise the interdisciplinary challenges and accordingly exchange information with other disciplines **Social competence** The students: • Present solutions for specific questions **Self-competence** The students: • reflect their solutions by using methods learned in this course
Module contents	• Medical areas and areas of application • Basic requirements for medical systems (hygiene, MPG, technical security, materials) • Medical systems: • Functional diagnostics (ECG, EMG, EEG) • Imaging systems (CT, MRI, ultrasound, PET, SPECT) - Therapy equipment (Laser, RF, Microtherapy) • Signal processing / monitoring (cardiovascular, hemodynamic, respiratory, metabolic, cerebral) • Medical Informatics (HIS, DICOM, Telemedicine, VR, image processing).
Reader's advisory	**essential:** • Kramme, R.: Medizintechnik. Verfahren, Systeme und Informationssysteme. Springer Verlag, 2002 (2. Auflage) • Lecture slides **recommended:** • Lehmann, Th.; Oberschelp, W.; Pelikan, E.; Pepges, R.: Bildverarbeitung in der Medizin. Springer Verlag, 1997

- Dugas, M.; Schmidt, K.: Medizinische Informatik und Bioinformatik. Springer Verlag, 2003

secondary literature:

- Taylor, R.H. et al.: Computer-Integrated Surgery. Technology and clinical Applikations. MIT Press, Cambridge, MA, 1996

Links	
Languages of instruction	English , German
Duration (semesters)	1 Semester
Module frequency	once a year
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	Pflicht o. Wahlpflicht / compulsory or optioal
Lehr-/Lernform / Teaching/Learning method	V+Ü
Vorkenntnisse / Previous knowledge	- Signal und Bildverarbeitung - Regelungstechnik

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture periode	Portfolio: Hands-on exercises, report, and written or oral exam

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	WiSe	42
Exercises		1	WiSe	14
Total time of attendance for the module				56 h

inf307 - Robotics

Module label	Robotics
Module code	inf307
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Nicht Informatik • Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule • Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction • Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction • Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering
Responsible persons	Lehrenden, Die im Modul (Authorized examiners) Hein, Andreas (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	**Professional competence** The students: • Name and know the functions and applications of robot systems • Characterise the basic concepts to program robot systems • Differentiate between the interaction of mechanical, electrical and software components **Methodological competence** The students: • Define characteristics and components of robot systems for a specific application • Design and implement robot system sub-components • Design and parameterise simple control structures • Plan the application of robot systems and derive the requirements • Model electrical and mechanical systems • Develop and realise simple robot systems **Social competence** The students: • Solve robot systems problems in team work **Self-competence** The students: • Reflect their solutions in reference to robot system methods

Module contents	• Integration in production plants / aims / subsystems
	• Architectures / classifications (classification of robots)
	• Robot components + Computer systems for programming
	  ◦ PA-10
	  ◦ Lego Mindstorms
	• Basics of kinematics
	  ◦ Coordinate transformation, homogeneous coordinates, Coordinate transitions
	  ◦ Kinematic equation systems, transformation of vectors
	• Kinematic
	  ◦ Joint types (manipulators) / Wheels, TCP
	  ◦ Denavit-Hartenberg-Transformation
	  ◦ Forward calculation
	  ◦ Backward calculation
	• Sensors
	  ◦ General properties of sensors, parameter
	  ◦ Simple optical position sensors
	  ◦ Inductive-, capacitive- und ultrasonic-sensors
	  ◦ Distance sensors (laser scanner, triangulation sensors)
	  ◦ Force sensors

- Sensor data preparation
- Planing / Regulation
  - Overall regulation approach, terms, process- and control functions, PID-controller
  - Planning concepts and approaches (On-Line, Off-Line), planning processes, construction and path planning
- Actuators

Reader's advisory	**essential:** lecture nodes **recommended:** Lüth, T.: Technische Multi-Agenten-Syteme. Hanser-Verlag, 1998. Siegert, H.-J.; Bocionek, S.: Programmierung intelligenter Roboter. Springer Verlag, 1996. Craig, J.J.: Introduction to Robotics: Mechanics and Control. Prentice Hall, 1989. Juckenack, D.: Handbuch der Sensortechnik: Messen mechanischer Größen. Verlag moderne Industrie, Landsberg/Lech, 1989. Jiang, X.; Bunke, H.: Dreidimensionales Computersehen (Gewinnung und Analyse von Tiefenbildern), Springer Verlag, 1997. **sekondary literature:** Hommel, G.; Heiß, H.: Roboterkinematik. Bericht 1990-15 an der TU-Berlin. Muir, P.F.; Neuman, C.P.: Kinematic Modeling of Wheeled Mobile Robots. Journal of Robotic Sytemes, 4(2) 281-340, 1987.
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	once a year
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	Pflicht o. Wahlpflicht / compulsory or optioal
Lehr-/Lernform / Teaching/Learning method	V+Ü
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture periode	Portfolio: Hands-on exercises, report, and written or oral exam

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	SuSe	42
Exercises		1	SuSe	14
Total time of attendance for the module				56 h

inf308 - Microrobotics II

Module label	Microrobotics II
Module code	inf308
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Nicht Informatik • Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule • Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction • Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction • Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering • Master's Programme Engineering Physics (Master) > Schwerpunkt: Laser and Optics
Responsible persons	Fatikow, Sergej (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	After having given an established introduction in the module “Microrobotics and Microsystem Technology” this lecture offers a further specialisation in microrobotics. Within the course, all relevant areas (among others the research topics of the division “Microrobotics and Control Engineering (AMiR)”) will be presented and analysed. The student will be provided with an insight into current research projects of AMiR and of other research institutes of microrobotics worldwide; here mainly the requirements of industry to microrobots will be discussed. The lecture will be enhanced by practical courses in the research laboratories of AMiR. **Professional competence** The students: • name and recognise the basic concepts of nanotechnology, in particular, micro- and nanorobotics approaches • differentiate the development, control and application of micro- and nanorobotics systems • implement and design application-specific mirco- and nanorobotics systems **Methodological competence** The students: • transfer their control engineering and image processing abilities on interdisciplinary problems • transfer their hands-on experience to develop controls and apllications of microrobotic systems on new tasks **Social competence** The students: • work in a team **Self-competence** The students: • reflect their problem-solving behaviour and use hands-on experience to develop, control and application of microrobotics
Module contents	Smart and versatile microrobots; microactuators (piezo-, ferrofluid- and SMA-actuators) for microrobots; real-time image processing in the micro world (SEM, optical microscopy); micro force sensors and tactile sensors for microrobots; microrobot control systems, e.g. neural networks and fuzzy logic; haptic interface for the control of microrobots; neural speech interface for the control of microrobots; robot-based micro- and nanohandling (SEM, optical microscopy); applications: microassembly, nano-testing, cell handling; Micro Air Vehicles (MAVs); multi-robot systems: team behavior, communication, control issues
Reader's advisory	• Lecture notes (can be obtained in secretariate, A1-3-303) • Fatikow, Sergej (Ed.): Automated Nanohandling by Microrobots, Springer, London, 2008
Links	

Languages of instruction	English , German
Duration (semesters)	1 Semester
Module frequency	once a year
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	Pflicht o. Wahlpflicht / compulsory or optioal
Lehr-/Lernform / Teaching/Learning method	V+Ü
Vorkenntnisse / Previous knowledge	Mikrorobotik und Mikrosystemtechnik

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture period	Oral Exam and exercises

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	SuSe	42
Exercises		1	SuSe	14
Total time of attendance for the module				56 h

inf311 - Low Energy System Design

Module label	Low Energy System Design
Module code	inf311
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule • Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction • Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering
Responsible persons	Lehrenden, Die im Modul (Authorized examiners) Nebel, Wolfgang (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	This module introduces the estimation of power dissipation and optimisation. **Professional competence** The students: • Discuss the fundamental problems of power dissipation • Characterise the requirements-driven design process of embedded systems • Name power loss analysis and optimization methods • Design embedded systems with common design and analysis tools • Design power-optimized embedded systems **Methodological competence** The students: • Model systems with a hardware description language • Analyze and model hardware components • Perform multi-dimensional optimization of systems **Social competence** The students: • Implement solutions of given problems in teams • Discuss their outcomes appropriately **Self-competence** The students: • Acknowledge the limits of their ability to cope with pressure during the modeling process of systems
Module contents	According to Moore’s Law the number of integratable transistors on a computer chip doubles every two years. In addition, new circuits are getting faster and faster. This leads not only to an increased functionality of a system, but it also increases the electrical power consumption. This electrical power consumption is problematic from two different points of view: Firstly, the electrical power must be supplied. Secondly, the resulting heat has to dissipate from the system. An increased power consumption always causes lower battery life and higher energy costs. The heat generation reduces the reliability and life of integrated circuits. The cooling (ceramic housings, cooling elements, fans, etc.) increases the system's costs. Today the development of heat, caused by power dissipation, needs to be considered during the embedded system design process. This knowledge takes the system's reliability and operation costs into account. This module introduces the estimation of power dissipation and optimisation.
Reader's advisory	• Designing CMOS Circuits for Low Power – Dimitros Soudris, Christian Piguet, Costas Goutis • Low-Power CMOS VLSI Circuit Design – Kaushik Roy, Sharat C. Prasad • Low-Power Electronics Design – Christian Piguet et al. • Leakage in Nanometer CMOS Technologies – Siva G. Narendra, Anantha Chandrakasan • Entwurf von digitalen Schaltungen und Systemen mit HDLs und FPGAs – F. Kesel, R. Bartholomä • Slides of the module „Eingebettete Systeme I+II“ von Professor Dr.-Ing. Wolfgang Nebel • Slides and technical readouts of the used hardware and development tools

Links	
Languages of instruction	English , German
Duration (semesters)	1 Semester
Module frequency	jährlich
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	Pflicht o. Wahlpflicht / compulsory or optioal
Lehr-/Lernform / Teaching/Learning method	V+Ü
Vorkenntnisse / Previous knowledge	- inf200 Grundlagen der Technische Informatik, - inf201 Technische Informatik, - inf203 Eingebettete Systeme I+, - inf204 Eingebettete Systeme II

Examination	Time of examination	Type of examination
Final exam of module	at the end of the lecture period	hands-on exercises and oral exam

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		2	WiSe	28
Exercises		2	WiSe	28
Total time of attendance for the module				56 h

inf350 - Special Topics in 'Safety-Critical Systems' I

Module label	Special Topics in 'Safety-Critical Systems' I
Module code	inf350
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Hein, Andreas (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	This module integrates current developments in the field in adequate study courses. **Professional competences** The students: • define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general • recognise and evaluate applied techniques and methods of their subject and are aware of their limits • identify, structure and solve problems/tasks, also in new or developing subject areas • apply state of the art and innovative methods to solve problems, if necessary from other disciplines • are aware of the current limits and contribute to the development of computer science research and technology • discuss and evaluate recent computer science developments **Methodological competences** The students: • evaluate and apply tools, technology and methods sophisticatedly • combine new and original approaches and methods creatively • evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research **Social competences** The students: • support team process by their abilities **Self-competences** The students: • pursue the overall and special computer science development critically • implement innovative professional activities effectively and independently
Module contents	See assigned course description, e.g. „Sicherheitsanalysetechniken“, „Zielarchitekturen Eingebetteter Systeme für Automotive-Anwendungen“, „Modellbasierter Systementwurf“, ...
Reader's advisory	As announced in course
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	unregelmäßig
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	2 Veranst. aus V, Ü, S, P, PR (4SWS)
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		Portfolio or presentation or oral exam

Course type	Course selection

SWS	4
Frequency	SoSe oder WiSe
Workload attendance	56 h

inf351 - Special Topics in 'Safety-Critical Systems' II

Module label	Special Topics in 'Safety-Critical Systems' II
Module code	inf351
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Hein, Andreas (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	This module integrates current developments in the field in adequate study courses. **Professional competences** The students: • define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general • recognise and evaluate applied techniques and methods of their subject and are aware of their limits • iIdentify, structure and solve problems/tasks, also in new or developing subject areas • apply state of the art and innovative methods to solve problems, if necessary from other disciplines • are aware of the current limits and contribute to the development of computer science research and technology • discuss and evaluate recent computer science developments **Methodological competences** The students: • evaluate and apply tools, technology and methods sophisticatedly • combine new and original approaches and methods creatively • evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research **Social competences** The students: • support team process by their abilities **Self-competences** The students: • pursue the overall and special computer science development critically • implement innovative professional activities effectively and independently
Module contents	See assigned course description, e.g. „Sicherheitsanalysetechniken“, „Modellbasierter Systementwurf“, ...
Reader's advisory	As announced in course
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	halbjährlich
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	2 Veranst. aus V, S, Ü, P, PR (4SWS)
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		Portfolio or presentation or oral exam

Course type	Course selection
SWS	4
Frequency	SoSe oder WiSe
Workload attendance	56 h

inf352 - Current Topics in 'Safety-Critical Systems' I

Module label	Current Topics in 'Safety-Critical Systems' I
Module code	inf352
Credit points	3.0 KP
Workload	90 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Hein, Andreas (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	This module integrates current developments in the field in adequate study courses. **Professional competences** The students: • define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general • recognise and evaluate applied techniques and methods of their subject and are aware of their limits • identify, structure and solve problems/tasks, also in new or developing subject areas • apply state of the art and innovative methods to solve problems, if necessary from other disciplines • are aware of the current limits and contribute to the development of computer science research and technology • discuss and evaluate recent computer science developments **Methodological competences** The students: • examine tasks with technical and research literature, write an academic article and present their solutions academically • evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research • schedule time processes and resources **Social competences** The students: • communicate with users and experts convincingly **Self-competences** The students: • pursue the overall and special computer science development critically • develop and reflect self-developed hypotheses to theories independently
Module contents	See assigned course description
Reader's advisory	As announced in course
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	unregelmäßig
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	S oder V (2 SWS)
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture period	Presentation or oral exam

Course type	Course or seminar
SWS	2
Frequency	SoSe oder WiSe
Workload attendance	28 h

inf353 - CurrentTopics in 'Safety-Critical Systems' II

Module label	CurrentTopics in 'Safety-Critical Systems' II
Module code	inf353
Credit points	3.0 KP
Workload	90 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Hein, Andreas (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	This module integrates current developments in the field in adequate study courses. **Professional competences** The students: • define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general • recognise and evaluate applied techniques and methods of their subject and are aware of their limits • identify, structure and solve problems/tasks, also in new or developing subject areas • apply state of the art and innovative methods to solve problems, if necessary from other disciplines • are aware of the current limits and contribute to the development of computer science research and technology • discuss and evaluate recent computer science developments **Methodological competences** The students: • examine tasks with technical and research literature, write an academic article and present their solutions academically • evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research • schedule time processes and resources **Social competences** The students: • communicate with users and experts convincingly **self-competences** The students: • pursue the overall and special computer science development critically • develop and reflect self-developed hypotheses to theories independently
Module contents	See assigned course description
Reader's advisory	As announced in course
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	unregelmäßig
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	S oder V (2SWS)
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture period	Presentation or oral exam

Course type	Course or seminar
SWS	2
Frequency	WiSe
Workload attendance	28 h

inf354 - Special Topics in 'Hybrid Systems' I

Module label	Special Topics in 'Hybrid Systems' I
Module code	inf354
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Hein, Andreas (Authorized examiners) Fränzle, Martin Georg (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	This module integrates current developments in the field in adequate study courses. **Professional competences** The students: • define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general • recognise and evaluate applied techniques and methods of their subject and are aware of their limits • identify, structure and solve problems/tasks, also in new or developing subject areas • apply state of the art and innovative methods to solve problems, if necessary from other disciplines • are aware of the current limits and contribute to the development of computer science research and technology • discuss and evaluate recent computer science developments **Methodological competences** The students: • evaluate and apply tools, technology and methods sophisticatedly • combine new and original approaches and methods creatively • evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research **Social competences** The students: • support team process by their abilities **self-competences** The students: • pursue the overall and special computer science development critically • implement innovative professional activities effectively and independently
Module contents	See assigned course description, e.g. „Modellbasierter Systementwurf“, „Konstruktionsprinzipien ausgewählter Klassen von Fahrzeugfunktionen“
Reader's advisory	As announced in course
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	halbjährlich
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	2 Veranst. aus V, Ü, S, P, PR (4SWS)
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture period	Exercises or presentation or oral exam

Course type	Course selection
SWS	2
Frequency	SoSe oder WiSe
Workload attendance	28 h

inf355 - Special Topics in 'Hybrid Systems' II

Module label	Special Topics in 'Hybrid Systems' II
Module code	inf355
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Hein, Andreas (Authorized examiners) Fränzle, Martin Georg (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	This module integrates current developments in the field in adequate study courses. **Professional competences** The students: • define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general • recognise and evaluate applied techniques and methods of their subject and are aware of their limits • identify, structure and solve problems/tasks, also in new or developing subject areas • apply state of the art and innovative methods to solve problems, if necessary from other disciplines • are aware of the current limits and contribute to the development of computer science research and technology • discuss and evaluate recent computer science developments **Methodological competences** The students: • evaluate and apply tools, technology and methods sophisticatedly • combine new and original approaches and methods creatively • evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research **Social competences** The students: • support team process by their abilities **Self-competences** The students: • pursue the overall and special computer science development critically • implement innovative professional activities effectively and independently
Module contents	See assigned course description
Reader's advisory	As announced in course
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	unregelmäßig
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	2 Veranst. aus V, Ü, S, P, PR (4SWS)
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture period	Exercises or presentation or oral exam

Course type	Course selection
SWS	2
Frequency	SoSe oder WiSe
Workload attendance	28 h

inf356 - CurrentTopics in 'Hybrid Systems' I

Module label	CurrentTopics in 'Hybrid Systems' I
Module code	inf356
Credit points	3.0 KP
Workload	90 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Hein, Andreas (Authorized examiners) Fränzle, Martin Georg (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	This module integrates current developments in the field in adequate study courses. **Professional competences** The students: • define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general • recognise and evaluate applied techniques and methods of their subject and are aware of their limits • identify, structure and solve problems/tasks, also in new or developing subject areas • apply state of the art and innovative methods to solve problems, if necessary from other disciplines • are aware of the current limits and contribute to the development of computer science research and technology • discuss and evaluate recent computer science developments **Methodological competences** The students: • examine tasks with technical and research literature, write an academic article and present their solutions academically • evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research • schedule time processes and resources **Social competences** The students: • communicate with users and experts convincingly **Self-competences** The students: • pursue the overall and special computer science development critically • develop and reflect self-developed hypotheses to theories independently
Module contents	See assigned course description
Reader's advisory	As announced in course
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	unregelmäßig
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	S oder V (2SWS)
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture period	Presentation or oral exam

Course type	Course or seminar
SWS	2
Frequency	SoSe oder WiSe
Workload attendance	28 h

inf357 - Aktuelle Themen aus dem Gebiet "Hybride Systeme" II

Module label	Aktuelle Themen aus dem Gebiet "Hybride Systeme" II
Module code	inf357
Credit points	3.0 KP
Workload	90 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Hein, Andreas (Authorized examiners) Fränzle, Martin Georg (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	This module integrates current developments in the field in adequate study courses. **Professional competences** The students: • define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general • recognise and evaluate applied techniques and methods of their subject and are aware of their limits • identify, structure and solve problems/tasks, also in new or developing subject areas • apply state of the art and innovative methods to solve problems, if necessary from other disciplines • are aware of the current limits and contribute to the development of computer science research and technology • discuss and evaluate recent computer science developments **Methodological competences** The students: • examine tasks with technical and research literature, write an academic article and present their solutions academically • evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research • schedule time processes and resources **Social competences** The students: • communicate with users and experts convincingly **Self-competences** The students: • pursue the overall and special computer science development critically • develop and reflect self-developed hypotheses to theories independently
Module contents	See assigned course description
Reader's advisory	As announced in course
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	unregelmäßig
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	S oder V (2SWS)
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture period	Presentation or oral exam

Course type	Course or seminar
SWS	2
Frequency	WiSe
Workload attendance	28 h

inf358 - Special Topics in 'Hardware/Software Systems' I

Module label	Special Topics in 'Hardware/Software Systems' I
Module code	inf358
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Hein, Andreas (Authorized examiners) Nebel, Wolfgang (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	This module integrates current developments in the field in adequate study courses. **Professional competences** The students: • define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general • recognise and evaluate applied techniques and methods of their subject and are aware of their limits • identify, structure and solve problems/tasks, also in new or developing subject areas • apply state of the art and innovative methods to solve problems, if necessary from other disciplines • are aware of the current limits and contribute to the development of computer science research and technology • discuss and evaluate recent computer science developments **Methodological competences** The students: • evaluate and apply tools, technology and methods sophisticatedly • combine new and original approaches and methods creatively • evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research **Social competences** The students: • support team process by their abilities **Self-competences** The students: • pursue the overall and special computer science development critically • implement innovative professional activities effectively and independently
Module contents	See assigned course description, e.g. „Spezifikation und Modellierung Eingebetteter Systeme“
Reader's advisory	As announced in course
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	halbjährlich
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	2 Veranst. aus V, Ü, S, P, PR (4SWS)
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination

Examination	Time of examination	Type of examination
Final exam of module	The exam period will be announced during the course	Portfolio or presentation or oral exam

Course type	Course selection
SWS	2
Frequency	SoSe oder WiSe
Workload attendance	28 h

inf359 - Spezielle Themen aus dem Gebiet "Hardware-/Software-Systeme" II

Module label	Spezielle Themen aus dem Gebiet "Hardware-/Software-Systeme" II
Module code	inf359
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Hein, Andreas (Authorized examiners) Nebel, Wolfgang (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	This module integrates current developments in the field in adequate study courses. **Professional competences** The students: • define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general • recognise and evaluate applied techniques and methods of their subject and are aware of their limits • identify, structure and solve problems/tasks, also in new or developing subject areas • apply state of the art and innovative methods to solve problems, if necessary from other disciplines • are aware of the current limits and contribute to the development of computer science research and technology • discuss and evaluate recent computer science developments **Methodological competences** The students: • evaluate and apply tools, technology and methods sophisticatedly • combine new and original approaches and methods creatively • evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research **Social competences** The students: • support team process by their abilities **Self-competences** The students: • pursue the overall and special computer science development critically • implement innovative professional activities effectively and independently
Module contents	See assigned course description, e.g. „Spezifikation und Modellierung Eingebetteter Systeme“
Reader's advisory	As announced in course
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	unregelmäßig
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	2 Veranst. aus V, Ü, S, P, PR (4SWS)
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination

Examination	Time of examination	Type of examination
Final exam of module	The exam period will be announced during the course	Exrecises or presentation or oral exam

Course type	Course selection
SWS	2
Frequency	WiSe
Workload attendance	28 h

inf360 - CurrentTopics in 'Hardware/Software Systems' I

Module label	CurrentTopics in 'Hardware/Software Systems' I
Module code	inf360
Credit points	3.0 KP
Workload	90 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Hein, Andreas (Authorized examiners) Nebel, Wolfgang (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	This module integrates current developments in the field in adequate study courses. Professional competences The students: • Define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general • Recognise and evaluate applied techniques and methods of their subject and are aware of their limits • Identify, structure and solve problems/tasks, also in new or developing subject areas • Apply state of the art and innovative methods to solve problems, if necessary from other disciplines • Are aware of the current limits and contribute to the development of computer science research and technology • Discuss and evaluate recent computer science developments Methodological competences The students: • Examine tasks with technical and research literature, write an academic article and present their solutions academically • Evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research • Schedule time processes and resources Social competences The students: • Communicate with users and experts convincingly Self-competences The students: • Pursue the overall and special computer science development critically • Develop and reflect self-developed hypotheses to theories independently
Module contents	See assigned course description, e.g. „Energieeffizienz in der IKT“, „Smart Resource Integration“, ...
Reader's advisory	As announced in course
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	unregelmäßig
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	S oder V (2SWS)
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture period	Presentation or oral exam

Course type	Course selection
SWS	2
Frequency	SoSe oder WiSe
Workload attendance	28 h

inf361 - Current Topics in 'Hardware/Software Systems' II

Module label	Current Topics in 'Hardware/Software Systems' II
Module code	inf361
Credit points	3.0 KP
Workload	90 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Hein, Andreas (Authorized examiners) Nebel, Wolfgang (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	This module integrates current developments in the field in adequate study courses. **Professional competences** The students: • define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general • recognise and evaluate applied techniques and methods of their subject and are aware of their limits • identify, structure and solve problems/tasks, also in new or developing subject areas • apply state of the art and innovative methods to solve problems, if necessary from other disciplines • are aware of the current limits and contribute to the development of computer science research and technology • discuss and evaluate recent computer science developments **Methodological competences** The students: • examine tasks with technical and research literature, write an academic article and present their solutions academically • evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research • echedule time processes and resources **Social competences** The students: • communicate with users and experts convincingly **Self-competences** The students: • pursue the overall and special computer science development critically • develop and reflect self-developed hypotheses to theories independently
Module contents	See assigned course description, e.g. „Energieeffizienz in der IKT“, „Smart Resource Integration“, ...
Reader's advisory	As announced in course
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	unregelmäßig
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	S oder V (2 SWS)
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture period	As announced in the according course

Course type	Course or seminar
SWS	2
Frequency	SoSe oder WiSe
Workload attendance	28 h

inf366 - Special Topics in 'Microrobotics and Control Engineering' I

Module label	Special Topics in 'Microrobotics and Control Engineering' I
Module code	inf366
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Hein, Andreas (Authorized examiners) Fatikow, Sergej (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	This module integrates current developments in the field in adequate study courses. **Professional competences** **The students:** • **define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general** • **recognise and evaluate applied techniques and methods of their subject and are aware of their limits** • **identify, structure and solve problems/tasks, also in new or developing subject areas** • **apply state of the art and innovative methods to solve problems, if necessary from other disciplines** • **are aware of the current limits and contribute to the development of computer science research and technology** • **discuss and evaluate recent computer science developments** Methodological competences **The students:** • **evaluate and apply tools, technology and methods sophisticatedly** • **combine new and original approaches and methods creatively** • **evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research** Social competences **The students:** • **support team process by their abilities** Self-competences** The students: • pursue the overall and special computer science development critically • implement innovative professional activities effectively and independently
Module contents	See assigned course description, e.g. „Nanomontage und Nanohandhabung“
Reader's advisory	As announced in course
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	jährlich
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	2 Veranst. aus V, S, Ü, P, PR (4SWS)

Vorkenntnisse / Previous knowledge		
Examination	Time of examination	Type of examination
Final exam of module	The exam period will be announced during the course	Portfolio or presentation or oral exam
Course type	Course selection	
SWS	2	
Frequency	SoSe oder WiSe	
Workload attendance	28 h	

inf367 - Spezielle Themen aus dem Gebiet "Mikrorobotik und Regelungstechnik" II

Module label	Spezielle Themen aus dem Gebiet "Mikrorobotik und Regelungstechnik" II
Module code	inf367
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Hein, Andreas (Authorized examiners) Fatikow, Sergej (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	This module integrates current developments in the field in adequate study courses. **Professional competences** The students: • define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general • recognise and evaluate applied techniques and methods of their subject and are aware of their limits • identify, structure and solve problems/tasks, also in new or developing subject areas • apply state of the art and innovative methods to solve problems, if necessary from other disciplines • are aware of the current limits and contribute to the development of computer science research and technology • discuss and evaluate recent computer science developments **Methodological competences** The students: • evaluate and apply tools, technology and methods sophisticatedly • combine new and original approaches and methods creatively • evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research **Social competences** The students: • support team process by their abilities **Self-competences** The students: • pursue the overall and special computer science development critically • implement innovative professional activities effectively and independently
Module contents	See assigned course description
Reader's advisory	As announced in course
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	unregelmäßig
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	2 Veranst. aus V, Ü, S, P, PR (4SWS)
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination

Examination	Time of examination	Type of examination
Final exam of module	The exam period will be announced during the course	Portfolio or presentation or oral exam

Course type	Course selection
SWS	2
Frequency	SoSe oder WiSe
Workload attendance	28 h

inf368 - Aktuelle Themen aus dem Gebiet "Mikrorobotik und Regelungstechnik" I

Module label	Aktuelle Themen aus dem Gebiet "Mikrorobotik und Regelungstechnik" I
Module code	inf368
Credit points	3.0 KP
Workload	90 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Hein, Andreas (Authorized examiners) Fatikow, Sergej (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	This module integrates current developments in the field in adequate study courses. **Professional competences** The students: • define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general • recognise and evaluate applied techniques and methods of their subject and are aware of their limits • identify, structure and solve problems/tasks, also in new or developing subject areas • apply state of the art and innovative methods to solve problems, if necessary from other disciplines • are aware of the current limits and contribute to the development of computer science research and technology • discuss and evaluate recent computer science developments **Methodological competences** The students: • examine tasks with technical and research literature, write an academic article and present their solutions academically • evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research • schedule time processes and resources **Social competences** The students: • communicate with users and experts convincingly **Self-competences** The students: • pursue the overall and special computer science development critically • develop and reflect self-developed hypotheses to theories independently
Module contents	See assigned course description
Reader's advisory	As announced in course
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	unregelmäßig
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	S oder V (2 SWS)
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture period	Presentation or oral exam

Course type	Course or seminar
SWS	2
Frequency	WiSe
Workload attendance	28 h

inf369 - Current Topics in 'Microrobotics and Control Engineering' II

Module label	Current Topics in 'Microrobotics and Control Engineering' II
Module code	inf369
Credit points	3.0 KP
Workload	90 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Hein, Andreas (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners) Fatikow, Sergej (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	This module integrates current developments in the field in adequate study courses. **Professional competences** The students: • define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general • recognise and evaluate applied techniques and methods of their subject and are aware of their limits • identify, structure and solve problems/tasks, also in new or developing subject areas • apply state of the art and innovative methods to solve problems, if necessary from other disciplines • are aware of the current limits and contribute to the development of computer science research and technology • discuss and evaluate recent computer science developments **Methodological competences** The students: • examine tasks with technical and research literature, write an academic article and present their solutions academically • evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research • schedule time processes and resources **Social competences** The students: • communicate with users and experts convincingly **Self-competences** The students: • pursue the overall and special computer science development critically • develop and reflect self-developed hypotheses to theories independently
Module contents	See assigned course description
Reader's advisory	As announced in course
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	unregelmäßig
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	S oder V (2 SWS)
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture period	Presentation or oral exam

Course type	Course or seminar
SWS	2
Frequency	SoSe oder WiSe
Workload attendance	28 h

inf374 - Special Topics in 'Automotive' I

Module label	Special Topics in 'Automotive' I
Module code	inf374
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Hein, Andreas (Authorized examiners) Fränzle, Martin Georg (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	This module integrates current developments in the field in adequate study courses. **Professional competences** The students: • define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general • recognise and evaluate applied techniques and methods of their subject and are aware of their limits • identify, structure and solve problems/tasks, also in new or developing subject areas • apply state of the art and innovative methods to solve problems, if necessary from other disciplines • are aware of the current limits and contribute to the development of computer science research and technology • discuss and evaluate recent computer science developments **Methodological competences** The students: • evaluate and apply tools, technology and methods sophisticatedly • combine new and original approaches and methods creatively • evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research **Social competences** The students: • support team process by their abilities **Self-competences** The students: • pursue the overall and special computer science development critically • implement innovative professional activities effectively and independently
Module contents	See assigned course description, e.g. „Zielarchitekturen Eingebetteter Systeme für Automotive-Anwendungen“
Reader's advisory	As announced in course
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	halbjährlich
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	2 Veranst. aus V, S, Ü, P, PR (4SWS)
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination

Examination	Time of examination	Type of examination
Final exam of module		Portfolio or presentation or oral exam

Course type	Course selection
SWS	2
Frequency	SoSe oder WiSe
Workload attendance	28 h

inf375 - Special Topics in 'Automotive' II

Module label	Special Topics in 'Automotive' II
Module code	inf375
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Hein, Andreas (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	This module integrates current developments in the field in adequate study courses. **Professional competences** The students: • define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general • recognise and evaluate applied techniques and methods of their subject and are aware of their limits • identify, structure and solve problems/tasks, also in new or developing subject areas • apply state of the art and innovative methods to solve problems, if necessary from other disciplines • are aware of the current limits and contribute to the development of computer science research and technology • discuss and evaluate recent computer science developments **Methodological competences** The students: • evaluate and apply tools, technology and methods sophisticatedly • combine new and original approaches and methods creatively • evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research **Social competences** The students: • Support team process by their abilities **Self-competences++ The students: • pursue the overall and special computer science development critically • implement innovative professional activities effectively and independently
Module contents	See assigned course description
Reader's advisory	As announced in course
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	unregelmäßig
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	2 Veranst. aus V, S, Ü, P, PR (4SWS)
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module	The exam period will be announced during the course	Portfolio or presentation or oral exam

Course type	Course selection
SWS	2
Frequency	WiSe
Workload attendance	28 h

inf376 - Current Topics in 'Automotive' I

Module label	Current Topics in 'Automotive' I
Module code	inf376
Credit points	3.0 KP
Workload	90 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Hein, Andreas (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	This module integrates current developments in the field in adequate study courses. Professional competences The students: • Define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general • Recognise and evaluate applied techniques and methods of their subject and are aware of their limits • Identify, structure and solve problems/tasks, also in new or developing subject areas • Apply state of the art and innovative methods to solve problems, if necessary from other disciplines • Are aware of the current limits and contribute to the development of computer science research and technology • Discuss and evaluate recent computer science developments Methodological competences The students: • Examine tasks with technical and research literature, write an academic article and present their solutions academically • Evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research • Schedule time processes and resources Social competences The students: • Communicate with users and experts convincingly Self-competences The students: • Pursue the overall and special computer science development critically • Develop and reflect self-developed hypotheses to theories independently
Module contents	See assigned course description
Reader's advisory	As announced in course
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	unregelmäßig
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	S oder V (2 SWS)
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture period	Presentation or oral exam

Course type	Course or seminar
SWS	2
Frequency	SoSe oder WiSe
Workload attendance	28 h

inf377 - Current Topics in 'Automotive' II

Module label	Current Topics in 'Automotive' II
Module code	inf377
Credit points	3.0 KP
Workload	90 h
Applicability of the module	• Master's Programme Computing Science (Master) > Technische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Hein, Andreas (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	This module integrates current developments in the field in adequate study courses. **Professional competences** The students: • define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general • recognise and evaluate applied techniques and methods of their subject and are aware of their limits • identify, structure and solve problems/tasks, also in new or developing subject areas • apply state of the art and innovative methods to solve problems, if necessary from other disciplines • are aware of the current limits and contribute to the development of computer science research and technology • discuss and evaluate recent computer science developments **Methodological competences** The students: • examine tasks with technical and research literature, write an academic article and present their solutions academically • evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research • schedule time processes and resources **Social competences** The students: • communicate with users and experts convincingly **Self-competences** The students: • pursue the overall and special computer science development critically • develop and reflect self-developed hypotheses to theories independently
Module contents	See assigned course description
Reader's advisory	As announced in course
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	unregelmäßig
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	S oder V (2 SWS)
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture period	Presentation or oral exam

Course type	Course or seminar
SWS	2
Frequency	SoSe oder WiSe
Workload attendance	28 h

inf450 - Correctness of Graph Programs

Module label	Correctness of Graph Programs
Module code	inf450
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Theoretische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Habel, Annegret (Module responsibility) Hein, Andreas (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	The objectives of this module are modelling of systems, system changes and system properties. Introduction to graph programs. Introduction into system correctness. Methods for proving system correctness. Professional competence The students: • Describe the basics of graph programs and graph properties • Describe verification procedures of system correctness Methodological competence The students: • Model systems, system changes and system properties • Apply the formalism of graph programs Social competence The students: • Solve problems in a team • Present and discuss their proposed solutions Self-competence The students: • Reflect upon their actions with regard to term rewriting systems and the methods of those
Module contents	The module is an introduction to the modelling of systems, system changes and system properties by means of graphs, graph programs and graph conditions and presents a method for proving correctness of systems with respect to a pre- and a postcondition. The basic structures used in this lecture are graphs; they are used in practically all domains of computing science for the representation of complex structures. Graph programs are constructed from the core constructs of nondeterministic rule application, sequential composition and iteration and they can effect programmatic changes of a graph structure. One well-known method for determining the correctness of programs with respect to a pre- and a postcondition is based on the construction of a weakest precondition of the postcondition with respect to the program and the attempt to decide whether the given precondition implies the computed weakest precondition.
Reader's advisory	• A. Habel, K.-H. Pennemann. Correctness of high-level transformation systems relative to nested conditions. Mathematical Structures in Computer Science, 19:245-296, 2009. • A. Habel, K.-H. Pennemann, A. Rensink. Weakest preconditions for high-level programs. In Graph Transformations (ICGT 2006), LNCS 4178, 445-460, 2006. • K. Azab, A. Habel, K.-H. Pennemann, C. Zuckschwerdt. ENFORCe: A system for ensuring formal correctness of high-level programs. In Electronic Communications of the EASST, Vol. 1. 82-93, 2007.
Links	
Language of instruction	German
Duration (semesters)	1 Semester

Module frequency	im 2-Jahres-Zyklus
Module capacity	unlimited
Reference text	Wird oft als Blockveranstaltung angeboten
Modullevel / module level	AC (Aufbaucurriculum / Composition)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	
Vorkenntnisse / Previous knowledge	- inf400 Theoretische Informatik I - inf401 Theoretische Informatik II

Examination	Time of examination	Type of examination
Final exam of module	Will be announced during the course	presentation or oral exam

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	WiSe	42
Exercises		1	WiSe	14
Total time of attendance for the module				56 h

inf453 - Combination of Specification Techniques

Module label	Combination of Specification Techniques
Module code	inf453
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Theoretische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Hein, Andreas (Authorized examiners) Olderog, Ernst-Rüdiger (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	inf400/inf401 Theoretische Informatik I and II
Skills to be acquired in this module	Introduction to the specification languages Z for data, CSP for processes, and their combination CSP-OZ for reactive systems with data and process parts. **Professional competence** The students: • specify data and processes with Z, CSP and CSP-OZ formally • check data refinement relations formally • verify CSP-OZ specifications with FDR model checker **Methodological competence** The students: - are able to integrate complementary specification methods **Social competence** The students: • work together in small groups to solve problems • present solutions to problems to groups of other students **Self-competence** The students: • learn persistence in pursuing difficult tasks • learn precision in specifying problems
Module contents	The course addresses a research trend in formal methods, the combination and integration of different specification methods. It focuses on a concrete combination CSP-OZ of the specification techniques CSP (Communicating Sequential Processes) for processes and Z and Object-Z for data, respectively. Reactive systems are described by CSP-OZ. As a preparation, the specification languages Z and CSP are described, followed by the combination CSP-OZ with its process-oriented semantics. The concepts of refinement and inheritance and the possibility of automatic verification of a sublanguage of CSP-OZ with the FDR model checker for CSP will be discussed. Finally, the course explains possibilities of extending CSP-OZ for the specification of time-critical systems. **Topics:** • specification of complex data and operations in Z, type definition and pattern calculations of Z, data refinement • specifications of communicating processes in CSP, operational semantics of CSP, three abstract semantic models for CSP: Trace semantics, failures semantics, failures-divergences semantics, process refinement in the above semantics, FDR model checker for CSP • combined specification method CSP-OZ, transformational semantics as CSP-process, theorems of refinements, object-oriented concepts of class and inheritance in CSP-OZ

Reader's advisory

Essential:

- M. Spivey. The Z Notation - A Reference Manual. Prentice Hall, 1989 (siehe http://spivey.oriel.ox.ac.uk/~mike/zrm/index.html).
- Jim Woodcock and Jim Davies. Using Z - Specification, Refinement, and Proof. Prentice Hall, 1996 (siehe http://www.usingz.com).
- A.W. Roscoe. The Theory and Practice of Concurrency. Prentice Hall, 1998.

Recommended:

- C. Fischer. CSP-OZ: A Combination of Object-Z and CSP. In H. Bowmann, J. Derrick (Editors). Formal Methods for Open Object-Based Distributed Systems (Chapman & Hall, 1997) 423-438.
- G. Smith. The Object-Z Specification Language. Kluwer Academic Publisher, 2000.

Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	unregelmäßig
Module capacity	unlimited
Modullevel / module level	BC (Basiscurriculum / Base curriculum)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	
Vorkenntnisse / Previous knowledge	- inf400 Theoretische Informatik I - inf401 Theoretische Informatik II

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture period	exercises and oral exam

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	WiSe	42
Exercises		1	WiSe	14
Total time of attendance for the module				56 h

inf454 - Communicating and Mobile Systems

Module label	Communicating and Mobile Systems
Module code	inf454
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Theoretische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule • Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering
Responsible persons	Lehrenden, Die im Modul (Authorized examiners) Olderog, Ernst-Rüdiger (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	Introduction to Milner's Calculus of Communicating Systems (CCS) and the ?-Calculus. **Professional competence** The students: • Know the theory of the operational semantics of CCS and the ?-calculus • Perform equivalence proofs using simulations and bisimulations • Specify communicating and mobile systems with CCS and the ?-calculus **Methodological competence** The students: • Learn about different views on mobility • Recognize equivalences as formal means for system correctness **Social competence** The students: • Work together in small groups to solve problems • Present their solutions to groups of other students **Self-competence** The students: • Learn persistence in pursuing difficult tasks • Learn precision in specifying problems
Module contents	Communication is one of the basic concepts of computer science. It occurs between computers in a network as well as between components of a computer. The focus of the course is on Robin Milner's ?-calculus. It enables a new modelling of communication, taking the location of the communication into account. The ?-calculus can describe the change of data in a computer as well as the sending of messages or even programs along networks like the internet. It is also possible to describe reconfigurable networks. This will be shown using the examples of mobile phones, schedulers, automatic vending machines, data structures, communication protocols, and objects in object-oriented programming. All these applications are backed by the theory of the ?-calculus, which is based on operational semantics and a concept of behavioural equivalence. The theory will be explained in a step-by-step manner. **Topics:** • different views on mobility • transition systems with simulations and bisimulations • Milner's Calculus of Communicating Systems (CCS) and Milner's ?-calculus for mobile systems, both with operational semantics, structural congruence, strong equivalence and observational equivalence, relationship between reactions and transitions, solvability of recursive equations • formal specification of examples of communicating and mobile systems using CCS and the ?-calculus • proof of strong equivalence and observational equivalence of given processes • specification of dynamic data structures in the ?-calculus
Reader's advisory	

- Robin Milner. Communicating and Mobile Systems: The pi-calculus. Cambridge University Press, 1999.
- Robin Milner. Communication and Concurrency. Prentice Hall, 1989.
- D. Sangiorgi and D. Walker. The pi-calculus: A Theory of Mobile Systems. Cambridge University Press, 2001.

Links	http://csd.informatik.uni-oldenburg.de/
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	irregulary
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	Pflicht o. Wahlpflicht / compulsory or optioal
Lehr-/Lernform / Teaching/Learning method	V+Ü
Vorkenntnisse / Previous knowledge	Theoretische Informatik II

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

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	WiSe	42
Exercises		1	WiSe	14
Total time of attendance for the module				56 h

inf456 - Real-Time Systems

Module label	Real-Time Systems
Module code	inf456
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Theoretische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule • Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction • Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering
Responsible persons	Lehrenden, Die im Modul (Authorized examiners) Olderog, Ernst-Rüdiger (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	Introduction to formal methods of the specification and verification of time sensitive systems and their combinations. **Professional competence** The students: • Learn about different models of time and real-time properties • Specify and verify real-time systems • Model real-time systems using Timed Automata and PLC-Automata • Apply the model checker UPPAAL for the verification of real-time properties • Specify real-time systems using the Duration Calculus • Learn about decidability and undecidability results for real-time systems **Methodological competence** The students: • Recognize logic and automata as adequate forms for describing real-time systems **Social competence** The students: • Work together in small groups to solve problems • Present their solutions to groups of other students **Self-competence** The students: • Learn persistence in pursuing difficult tasks • Learn precision in specifying problems
Module contents	Examples of time-critical systems are railway control systems, robots, or even gas burners. It is essential for these systems to comply with certain timing conditions. For example, the control of a railway crossing must close the gates not later than 4 seconds after the sensors have reported an approaching train. If the gates are open, they should stay that way for at least 15 seconds to allow for a safe crossing of vehicles. Different specification methods have been developed to describe such timing conditions. The Duration Calculus developed by Zhou Chaochen in 1991 is one attractive method. It is a logic combined with a calculus, in which the duration of states can be described. The course will introduce the Duration Calculus and will explain its application by means of examples. As further specification method Timed Automata introduced by Alur & Dill in 1994 will be presented. After the specification of real-time system requirements the verification of programs implementing these requirements will follow. The specification methods of the Duration Calculus and Timed Automata are used to describe the real-time behaviour of these programs. The correctness is then proven on the basis of these behavioral descriptions. Topics: • discrete and continuous model of time • logics and automata models for the specification of real-time systems (predicate logic, Duration Calculus, Timed CTL, Timed Automata, PLC-Automata) • decidability and undecidability results for real-time systems

- model checker UPPAAL for Timed Automata
- formal specification of real-time systems using Duration Calculus as well as Timed Automata and PLC-Automata
- verification of concrete Timed Automata using the model checker UPPAAL,
- transformation of Duration Calculus for discrete time into regular languages
- implementability of real-time systems on PLC-like hardware

Reader's advisory	essential: • E.-R. Olderog, H. Dierks: Real-Time Systems: Formal Specification and Automatic Verification, Cambridge University Press, 2008 recommended: • C. Heitmeyer and D. Madrioli, editors. Formal Methods for Real-Time Computin, Wiley, 1996. • M. Joseph, editor. Real-time Systems -- Specification, Verification and Analysis, Prentice Hall, 1996 (http://docencia.etsit.urjc.es/moodle/file.php/31/documentos/RTSbook.pdf).
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	irregulary
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	Pflicht o. Wahlpflicht / compulsory or optioal
Lehr-/Lernform / Teaching/Learning method	V+Ü
Vorkenntnisse / Previous knowledge	Theoretische Informatik I + II

Examination	Time of examination	Type of examination
Final exam of module	At the end of the lecture period	Exercises and written or oral exam

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	SoSe oder WiSe	42
Exercises		1	SoSe oder WiSe	14
Total time of attendance for the module				56 h

inf458 - Term Rewriting Systems

Module label	Term Rewriting Systems
Module code	inf458
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Theoretische Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Habel, Annegret (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	The objectives of this module are an introduction to (term) rewriting systems, termination and confluence, the undecidable sets of termination and confluence problems, verifcation procedures of termination and confluence **Professional competence** The students: • describe the basics of term rewriting systems • characterise the undecidability of termination and confluence problems • describe verification procedures of termination and confluence **Methodological competence** The students: • apply verification procedures of termination and confluence • apply Huet’s completion procedure **Social competence** The students: • solve problems in a team • present and discuss their results **Self-competence** The students: • reflect their actions with regard to term rewriting systems and the methods of those
Module contents	The module is an introduction to term rewriting systems and provides verification procedures for termination and confluence. Term rewriting systems, termination and confluence are introduced, the undecidability of termination and confluence problems and the decidability for a set of special term rewriting systems are shown. For this purpose reduction and simplification orders, critical pairs, orthogonality and Huet's completion procedure are introduced, examined and combined.
Reader's advisory	• Franz Baader, Tobias Nipkow: Term Rewriting and All That. Cambridge University Press, Cambridge 1998. • Terese: Term Rewriting Systems, Cambridge University Press, Cambridge, 2003.
Links	
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	im 2-Jahres-Zyklus
Module capacity	unlimited
Reference text	Blockveranstaltung
Modullevel / module level	AC (Aufbaucurriculum / Composition)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning	

method				
Vorkenntnisse / Previous knowledge				
Examination		Time of examination	Type of examination	
Final exam of module		At the end of the lecture period	exercises and oral or written exam	
Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		3	WiSe	42
Exercises		1	WiSe	14
Total time of attendance for the module				56 h

inf513 - Simulation-based Smart Grid Engineering and Assessment

Module label	Simulation-based Smart Grid Engineering and Assessment
Module code	inf513
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik • Master's Programme Computing Science (Master) > Angewandte Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Lehrenden, Die im Modul (Authorized examiners) Lehnhoff, Sebastian (Module responsibility)
Prerequisites	Programming with JAVA
Skills to be acquired in this module	Successfully completing this lecture will enable the students to mathematically model simple controllable electrical generators and consumers and to simulate them together with appropriate control algorithms within smart grid scenarios. To achieve this goal, students will start with deriving computational models from physical models and evaluate them. In order to manage the integration of control algorithms, students are taught the principles of cosimulation using the "mosaik" smart grid co-simulation framework as an example. Students will be able to understand and apply distributed, agent-based control schemes to decentralized energy generators and/ or consumers. As a result, students are able to analyze the requirements for successful application to real power balancing regarding capacity utilization, robustness, and flexibility. In addition, students learn the foundations of planning and conducting simulation based experiments as well as the interpretation of the results. Special attention will be paid on establishing a balance between the results' precision and robustness and the necessary effort (design of experiments) in order to gain as much insight into interdependencies with as few experiments as possible. **Professional competence** The students: • derive and evaluate computational models from physical models • use the "mosaik" smart grid co-simulation framework • analyze the requirements for successful applications to real power balancing regarding capacity utilization, robustness, and flexibility • name the foundations of planning and conducting simulation based experiments as well as the interpretation of the results • are aware of the balance between the results' precision and robustness and the necessary effort (design of experiments) in order to gain as much insight into interdependencies with as few experiments. **Methodological competence** The students: • model simple controllable electrical generators and consumers • simulate simple controllable electrical generators and consumers with appropriate control algorithms within smart grid scenarios • apply distributed agent-based control schemes to decentralized energy generators and/ or consumers • evaluate simulation results • search information and look into methods to implement models • propose hyphothesis and check their validity with design of experiments methods **Social competence** The students: • apply the pair progamming development technique • discuss design decisions • identify work packages and are responsible for it **Self-competence** The students: • reflect on their own use of power as a limited resource • accept and use criticism to develop their own behaviour
Module contents	**In this practical course students:**

- model controllable, modulating electrical energy generators and consumers,
- put their hands on mosaik (installation, description and configuration of scenarios, conduction of simulations),
- learn the principles of agent-based heuristics for optimization problems in future smart grid scenarios,
- learn about the challenges of implementing agent-based mechanisms (multi-criticality, convergency, quality) on the training,
- learn the foundations for choice and design of simulation based experiments.

Reader's advisory	**Suggested reading:** **Smart Grids:** • Konstantin, P.: "Praxisbuch Energiewirtschaft", Springer, 2006 • Schwab, A.: "Elektroenergiesysteme", Springer, 2009 **Multiagentensysteme:** • Sutton, R. S.; Barto, A. G.: "Reinforcement Learning", MIT Press, 1998 • Weiss, G.: "Multiagent Systems", MIT Press, 2013 • Ferber J.; Kirn, S.: "Multiagentensysteme: eine Einführung in die Verteilte Künstliche Intelligenz", Addison-Wesley, 2001 **Co-Simulation** • Ptolemaeus, C.: "System Design, Modeling, and Simulation", UC Berkeley, 2013 • Law, A.: "Simulation Modeling and Analysis", McGraw-Hill, 2015 **Versuchsplanung:** • Kleppmann, W.: "Versuchsplanung", Hanser, 2013 • Klein, B.: "Versuchsplanung - DoE", Oldenbourg, 2011 • Goos, P.; Jones, B.: "Optimal Design of Experiments", Wiley, 2014 • Box, G. E. P.; Hunter, J. S.; Hunter, W. G.: "Statistics for Experimenters", Wiley, 2005 • Forrester, A.; Sobester, A.; Keane, A.: "Engineering Design via Surrogate Modelling", Wiley, 2008
Links	http://mosaik.offis.de
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	jährlich
Module capacity	unlimited
Reference text	Elective module in the master specialization area (energy computer science). Associated with the modules: • Energieinformationssysteme • Smart Grid Management
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	
Vorkenntnisse / Previous knowledge	- Programmierung mit Java - Programmierung mit Python

Examination	Time of examination	Type of examination
Final exam of module	At the end of the semester	Oral exam

Course type	Practical training
SWS	4
Frequency	SuSe
Workload attendance	56 h

inf533 - Probabilistic Modelling I

Module label	Probabilistic Modelling I
Module code	inf533
Credit points	3.0 KP
Workload	90 h
Applicability of the module	• Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik • Master's Programme Computing Science (Master) > Angewandte Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule • Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction • Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering
Responsible persons	Möbus, Claus (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	Probabilistic Bayesian models are generated with special tools (e.g. BUGS, JAGS, STAN) or domain specific programming languages (, WebPPL, PyMC3, …etc.). If they mimic cognitive processes of humans (e.g. pilots, drivers) or animals they could be used as cooperative assistance systems in technical or financial systems like cars,robots, or recommenders. **Professional competence** The students: • learn to map problem to model classes to come up with practical solutions **Methodological competence** The students: • acquire basic skills in the design, implementation, and identification of probabilistic models with Bayesian methods • acquire knowledge about alternative non-Bayesian machine learning methods **Social competence** The students: • learn to present and discuss probabilistic theories, methods, and models. **Self-competence** The students: • reflect and evaluate chances and limitations of probabilistic approaches • learn to deliberate on machine-learning alternatives
Module contents	Theories, methods, and examples of Bayesian models with practical applications
Reader's advisory	Recent eBooks, eTutorials
Links	http://www.uni-oldenburg.de/en/computingscience/lcs/probabilistic-programming/
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	jährlich
Module capacity	unlimited
Reference text	Associated with the module: • inf534 Probabilistic Modelling II
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	S

Vorkenntnisse / Previous knowledge	Programmierkenntnisse	
Examination	Time of examination	Type of examination
Final exam of module	Will be announced in the lecture	Presentation, reflective summary
Course type	Seminar	
SWS	2	
Frequency	WiSe	
Workload attendance	28 h	

inf534 - Probabilistic Modelling II

Module label	Probabilistic Modelling II
Module code	inf534
Credit points	3.0 KP
Workload	90 h
Applicability of the module	• Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik • Master's Programme Computing Science (Master) > Angewandte Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule • Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
Responsible persons	Möbus, Claus (Authorized examiners) Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	Probabilistic models are generated with special tools (e.g. BUGS, JAGS, STAN) or domain specific programming languages (WebPPL, PyMC3, … , etc.). If they mimic cognitive processes of humans (e.g. pilots, drivers) or animals they could be used as cooperative assistance systems in technical or financial systems like cars, robots, or recommenders. In this part of the seminar we read, present, and discuss recent research papers. **Professional competence:** The students: • learn to connect problem- with model classes to come up with practical solutions **Methodological competence** The students: • acquire advanced skills in the design, implementation, and identification of probabilistic models with Bayesian methods • acquire knowledge about alternative machine learning methods **Social competence** The students: • learn to present and discuss probabilistic theories, methods, and models **Self-competence** The students: • reflect and evaluate chances and limitations of probabilistic approaches • learn to deliberate on machine-learning alternatives
Module contents	Theories, methods, and examples of Bayesian models with practical applications
Reader's advisory	Recent publications
Links	http://www.uni-oldenburg.de/en/computingscience/lcs/probabilistic-programming/
Language of instruction	German
Duration (semesters)	1 Semester
Module frequency	halbjährlich
Module capacity	unlimited
Reference text	**Associated wiht the module:** • inf533 Probabilistische Modellierung I
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	

Vorkenntnisse / Previous knowledge	- Grundkenntnisse Progeammierung	
Examination	Time of examination	Type of examination
Final exam of module	individuell in Absprache mit dem Lehrenden	seminar talk, reflective written summary
Course type	Seminar	
SWS	2	
Frequency	SuSe	
Workload attendance	28 h	

inf950 - Interdisciplinary Module I

Module label	Interdisciplinary Module I
Module code	inf950
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Computing Science (Master) > Nicht Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	Lehrenden, Die im Modul (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	**Ziele des Moduls/Kompetenzen:** Die Absolventinnen und Absolventen kennen die Grundlagen und anwendungsrelevanten Hintergründe der ausgewählten Disziplin. **Fachkompetenzen** Die Studierenden: • benennen die Grundlagen und Methoden des gewählten Gebietes • wenden die Fachsprache des Anwendungsgebietes kompetent an **Methodenkompetenzen** Die Studierenden: • charakterisieren Nutzungskontext und Anforderungen von IT im gewählten Gebiet • wenden die disziplinären Methoden und Techniken des Anwendungsgebietes an und kontrastieren diese mit den aus der Informatik bekannten Methoden und Techniken • untersuchen Probleme eines Anwendungsgebietes mit den disziplin-typischen Methoden **Sozialkompetenzen** Die Studierenden: • können die Verschiedenheit von Fachkulturen einschätzen und respektieren andere Fachgebiete und deren Arbeitsweise • bereiten sich auf Anwendungsszenarien für IT-Systeme vor **Selbstkompetenzen** Die Studierenden: • reflektieren ihr Selbstbild und Handeln vor dem Hintergrund einer anderen Fachdisziplin
Module contents	Das Modul wird mit Fachmodulen aus anderen Disziplinen oder Modulen des Departments für Informatik instanziiert, die als Nicht Informatik-Modul gekennzeichnet sind. Die Veranstaltungsformen und Prüfungsmodalitäten orientieren sich an dem jeweils gewählten Modul.
Reader's advisory	
Links	
Languages of instruction	
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel / module level	AS (Akzentsetzung / Accentuation)
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht
Lehr-/Lernform / Teaching/Learning method	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		M
Course type	Course selection	

SWS	2
Frequency	WiSe
Workload attendance	28 h

inf951 - Interdisciplinary Module II

Module label		Interdisciplinary Module II	
Module code		inf951	
Credit points		6.0 KP	
Workload	180 h		
Applicability of the module	• Master's Programme Computing Science (Master) > Nicht Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule		
Responsible persons			
Prerequisites			
Skills to be acquired in this module			
Module contents			
Reader's advisory			
Links			
Languages of instruction			
Duration (semesters)	1 Semester		
Module frequency			
Module capacity	unlimited		
Modullevel / module level	BC (Basiscurriculum / Base curriculum)		
Modulart / typ of module	je nach Studiengang Pflicht oder Wahlpflicht		
Lehr-/Lernform / Teaching/Learning method			
Vorkenntnisse / Previous knowledge			
Examination		Time of examination	Type of examination
Final exam of module			M
Course type	Course selection		
SWS	2		
Frequency	WiSe		
Workload attendance	28 h		

inf514 - Simulation-based Smart Grid Engineering and Assessment

Module label	Simulation-based Smart Grid Engineering and Assessment
Module code	inf514
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik • Master's Programme Computing Science (Master) > Angewandte Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	
Prerequisites	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel / module level	MM (Mastermodul / Master module)
Modulart / typ of module	Wahlpflicht / Elective
Lehr-/Lernform / Teaching/Learning method	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		mündliche Prüfung

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		2	SoSe oder WiSe	28
Exercises		2	SoSe oder WiSe	28
Total time of attendance for the module				56 h

inf515 - Intelligent Energy Systems

Module label	Intelligent Energy Systems
Module code	inf515
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik • Master's Programme Computing Science (Master) > Angewandte Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	
Prerequisites	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel / module level	MM (Mastermodul / Master module)
Modulart / typ of module	Wahlpflicht / Elective
Lehr-/Lernform / Teaching/Learning method	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		Portfolio oder mündliche Prüfung oder Klausur

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		2	SoSe oder WiSe	28
Exercises		2	SoSe oder WiSe	28
Total time of attendance for the module				56 h

inf516 - Agent-based Methods in Energy Systems

Module label	Agent-based Methods in Energy Systems
Module code	inf516
Credit points	6.0 KP
Workload	180 h
Applicability of the module	• Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik • Master's Programme Computing Science (Master) > Angewandte Informatik • Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
Responsible persons	
Prerequisites	
Skills to be acquired in this module	
Module contents	
Reader's advisory	
Links	
Languages of instruction	German, English
Duration (semesters)	1 Semester
Module frequency	
Module capacity	unlimited
Modullevel / module level	MM (Mastermodul / Master module)
Modulart / typ of module	Wahlpflicht / Elective
Lehr-/Lernform / Teaching/Learning method	
Vorkenntnisse / Previous knowledge	

Examination	Time of examination	Type of examination
Final exam of module		Portfolio oder mündliche Prüfung oder Klausur

Course type	Comment	SWS	Frequency	Workload of compulsory attendance
Lecture		2	SoSe oder WiSe	28
Exercises		2	SoSe oder WiSe	28
Total time of attendance for the module				56 h

Abschlussmodul

mam - Master´s Thesis Module

Module label	Master´s Thesis Module
Module code	mam
Credit points	30.0 KP
Workload	900 h
Applicability of the module	• Master's Programme Embedded Systems and Microrobotics (Master) > Abschlussmodul
Responsible persons	Sonnenschein, Michael (Module responsibility) der Informatik, Lehrende (Authorized examiners)
Prerequisites	
Skills to be acquired in this module	The students prove that they are able to process and solve complex computer science tasks based on gained scientific knowledge and applied research methods. The students successfully implement a task especially by using their acquired professional and methodological knowledge and their professional and social competences. The accompanying seminar is used to discuss the master's thesis methodically and content-related. During the seminar the exchange of research and practical experience fosters the students' ability to discuss and evaluate their thesis with other students and experts. The master's thesis is finished by a colloquium. Professional competence The students: • Recognise and evaluate applied techniques and methods of their subject and are aware of their limits • Design solutions for complex, possibly vaguely defined or unusual computer science tasks/problems and evaluate these with reference to state of the art computer science and technology • Identify, structure and solve problems/tasks, also in new or developing subject areas • Apply state of the art and innovative methods to solve problems, if necessary from other disciplines • Relate knowledge from different disciplines and apply this new knowledge in complex situations • Develop complex computer systems, processes and datamodels • Are aware of the current limits and contribute to the development of computer science research and technology • Discuss and evaluate recent computer science developments Methodological competence The students: • Identify and develop one or more solutions • Evaluate and apply tools, technology and methods sophisticatedly • Examine tasks with technical and research literature, write an academic article and present their solutions academically • Schedule processes and resources • Apply project management techniques • Combine new and original approaches and methods creatively • Evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research Social competence The students: • Communicate with users and experts convincingly • Take reasonable decisions Self-competence The students: • Pursue the overall and special computer science development critically • Implement innovative professional activities effectively and independently • Recognise their abilities and extend them purposefully • Reflect their self-perception and actions with regard to professional, methodological and social aspects • Develop and reflect self-developed hypotheses to theories independently • Work in their field independently

Module contents	The content of this module is an independent topic research. The research findings will be presented and discussed in a master's thesis colloquium.	
Reader's advisory	Wird entsprechend des konkreten Themas spezifiziert.	
Links	https://www.uni-oldenburg.de/informatik/studium-lehre/infos-zum-studium/abschlussarbeiten/	
Languages of instruction	German, English	
Duration (semesters)	1 Semester	
Module frequency	halbjährlich	
Module capacity	unlimited	
Modullevel / module level	Abschlussmodul (Abschlussmodul)	
Modulart / typ of module	Pflicht	
Lehr-/Lernform / Teaching/Learning method	Anfertigen einer Masterarbeit	
Vorkenntnisse / Previous knowledge		
Examination	Time of examination	Type of examination
Final exam of module	individuell	Master's thesis, presentation and discussion.
Course type	Seminar	
SWS		
Frequency	SoSe und WiSe	
Workload attendance	0 h	