

## Modules for Embedded Systems and Microrobotics

Date 15/10/19

# Kernmodule

## inf900 - Group Project

<b>Module label</b>	Group Project
<b>Module code</b>	inf900
<b>Credit points</b>	24.0 KP
<b>Workload</b>	720 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Business Informatics (Master) &gt; Kernmodule</li> <li>• Master's Programme Computing Science (Master) &gt; Kernmodule</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Kernmodule</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Systems Engineering</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>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.</p> <p>Additionally, students develop special knowledge, skills and competences from the project group topic.</p> <p><b>Professional competence</b> The students:</p> <ul style="list-style-type: none"> <li>• characterise and apply computer science basics (algorithms, data structures, programming, basics of practical, technical and theoretical computer science)</li> <li>• define und describe essential mathematical, logical and physical basics of computer science</li> <li>• define and illustrate the core disciplines of computer science (theoretical, practical and technical computer science)</li> </ul> <p><b>Methodological competence</b> The students:</p> <ul style="list-style-type: none"> <li>• examine problems, use formal methods to phrase and analyze them appropriately</li> <li>• evaluate problems by the use of technical and scientific literature</li> <li>• reflect on a scientific topic and write a scientific seminar paper under guidance and present their findings</li> </ul> <p><b>Social competence</b> The students:</p> <ul style="list-style-type: none"> <li>• integrate criticism into their own actions</li> <li>• respect team decisions</li> <li>• communicate with users and experts convincingly</li> </ul> <p><b>Self-competence</b> The students:</p> <ul style="list-style-type: none"> <li>• take on project management tasks</li> <li>• pursue the overall and special computer science development critically</li> <li>• implement innovative professional activities effectively and independently</li> <li>• recognise their abilities and extend them purposefully</li> <li>• reflect their self-perception and actions with regard to professional, methodological and social aspects</li> <li>• develop and reflect self-developed hypotheses to theories independently</li> <li>• work in their field independently</li> </ul>
<b>Module contents</b>	Cooperative development of a large-scale computer science project. This project general includes the (further) development of a hard or software system.
<b>Reader's advisory</b>	According to the assigned task

<b>Links</b>	<a href="https://www.uni-oldenburg.de/informatik/studium-lehre/infos-zum-studium/projektgruppen-im-masterstudium/">https://www.uni-oldenburg.de/informatik/studium-lehre/infos-zum-studium/projektgruppen-im-masterstudium/</a>	
<b>Languages of instruction</b>	German, English	
<b>Duration (semesters)</b>	2 Semester	
<b>Module frequency</b>	semi-annual	
<b>Module capacity</b>	unlimited	
<b>Reference text</b>	Dieses Modul ist im Rahmen der Projekte FIIF und FoL konzipiert worden	
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)	
<b>Modulart</b>	Pflicht o. Wahlpflicht / compulsory or optioal	
<b>Lern-/Lehrform / Type of program</b>	PG	
<b>Vorkenntnisse / Previous knowledge</b>	<ul style="list-style-type: none"> <li>- Programmierkurs</li> <li>- Softwaretechnik</li> <li>- Soft Skills</li> </ul>	
<b>Examination</b>	Time of examination	Type of examination
<b>Final exam of module</b>	Im Stud.IP nach Bekanntgabe der einzelnen Gruppen und Themen	Active involvement, presentation, final report, project assessment
<b>Course type</b>	Project group	
<b>SWS</b>	8.00	
<b>Frequency</b>	SuSe and WiSe	
<b>Workload attendance</b>	112 h	

# Akzentsetzungsmodule

## inf100 - Human Computer Interaction

<b>Module label</b>	Human Computer Interaction
<b>Module code</b>	inf100
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Business Informatics (Master) &gt; Akzentsetzungsmodule der Informatik</li> <li>• Master's Programme Computing Science (Master) &gt; Praktische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Embedded Brain Computer Interaction</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Human-Computer Interaction</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Susanne Boll-Westermann</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Susanne Boll-Westermann</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p><b>Professional competence</b> The students:</p> <ul style="list-style-type: none"> <li>• Name the human-computer interaction core principles</li> <li>• Characterise the basic elements of the human-centered design of interactive systems</li> </ul> <p><b>Methodological competence</b> The students:</p> <ul style="list-style-type: none"> <li>• Comprehend context of use and user requirements of human-machine interfaces</li> <li>• Design, develop and evaluate human-machine interfaces</li> <li>• Conduct experiments with their prototypes</li> </ul> <p><b>Social competence</b> The students:</p> <ul style="list-style-type: none"> <li>• Implement human-computer interfaces in practical hands-on projects in teams</li> <li>• Evaluate human-machine interfaces with potential users</li> <li>• Develop and present solutions for Human-Computer Interaction related problems</li> <li>• Integrate technical and factual comments into own results</li> </ul>
<b>Module contents</b>	<p>The module introduces the field of human-computer interfaces and their historical context. Moreover, it shows motivating examples of human-computer interaction.</p> <p>The module covers the core principles of human-computer interaction. In detail, the module deals with the design concepts of interactive systems: context of use, requirements and task analysis, human perception capabilities, design process, usability, prototyping and evaluation. During the practical project a concrete human-computer interface will be designed, developed and evaluated according to this concepts.</p>
<b>Reader's advisory</b>	<ul style="list-style-type: none"> <li>• Alan Dix, Jane Finlay, Gegory Abowd, Russel Beale, Human Computer Interaction Person, 2004.</li> <li>• Markus Dahm, Grundlagen der Mensch Computer-Interaktion. Pearson, 2006</li> <li>• Literature in the reserve shelf in the university bibliography. Link list in Stud.IP.</li> </ul>
<b>Links</b>	<a href="http://medien.informatik.uni-oldenburg.de/lehre">medien.informatik.uni-oldenburg.de/lehre</a>
<b>Languages of instruction</b>	German, English
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	once a year
<b>Module capacity</b>	unlimited

<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)		
<b>Modulart</b>	Pflicht o. Wahlpflicht / compulsory or optional		
<b>Lern-/Lehrform / Type of program</b>	V+P		
<b>Vorkenntnisse / Previous knowledge</b>	Grundkenntnisse Programmierung		
<b>Examination</b>	Time of examination	Type of examination	
<b>Final exam of module</b>	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. Find out more about the schedule 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.	
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>
Lecture		2.00	SuSe
Tutorial		2.00	SuSe
<b>Total time of attendance for the module</b>			<b>56 h</b>

## inf105 - Fault Tolerance in Distributed Systems

<b>Module label</b>	Fault Tolerance in Distributed Systems
<b>Module code</b>	inf105
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Praktische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Oliver Theel</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Die im Modul Lehrenden</li> <li>◦ Die Modulverantwortlichen</li> </ul> <p>Module counseling</p> <ul style="list-style-type: none"> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>This module provides knowledge of fault-tolerant distributed systems. The terminology, structure, conception, core challenges and related implementation concepts will be covered in detail.</p> <p>Professional competence The students:</p> <ul style="list-style-type: none"> <li>• Assess what a fault-tolerant distributed system is and develop awareness of its capabilities</li> <li>• Name and discuss common implementations of fault-tolerant distributed systems</li> </ul> <p>Methodological competence The students:</p> <ul style="list-style-type: none"> <li>• Reflect the implementation challenges of a distributed system</li> <li>• Are able to adapt and evolve implementation concepts of fault-tolerant distributed systems in new contexts</li> </ul> <p>Social competence The students:</p> <ul style="list-style-type: none"> <li>• Solve problems in small teams</li> <li>• Present their solutions to the members of the tutorial</li> <li>• Discuss their different solutions with members of the tutorial</li> </ul> <p>Self-competence The students:</p> <ul style="list-style-type: none"> <li>• Accept criticism</li> <li>• Question their initially applied methods for problem solving</li> <li>• Question their initial solutions in the light of newly learned methods</li> </ul>
<b>Module contents</b>	<ol style="list-style-type: none"> <li>1) Fault, Error, Failure</li> <li>2) Failure semantics, Fault tolerance</li> <li>3) Byzantine agreement protocols</li> <li>4) Stable storage</li> <li>5) Fail-stop processors</li> <li>6) Atomic commit protocols</li> <li>7) Classification of replication control schemes <ul style="list-style-type: none"> <li>• pessimistic vs. optimistic</li> <li>• semantic vs. syntactic</li> <li>• static vs. dynamic</li> </ul> </li> <li>8) Consistency notions</li> <li>9) Quality criteria</li> <li>10) Survey of replication control schemes</li> </ol>

- 11) Design of replication control schemes
- 12) Unifying frameworks
- 13) Replication in practice

<b>Reader's advisory</b>	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			
<b>Links</b>				
<b>Language of instruction</b>	German			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>	jährlich			
<b>Module capacity</b>	unlimited			
<b>Reference text</b>	connectet with: Betriebssysteme 1 und 2 Betriebssysteme-Praktikum Verteilte Betriebssysteme			
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)			
<b>Modulart</b>	Wahlpflicht / Elective			
<b>Lern-/Lehrform / Type of program</b>	V+S bzw V+Ü			
<b>Vorkenntnisse / Previous knowledge</b>	Verteilte Betriebssysteme			
<b>Examination</b>	Time of examination	Type of examination		
<b>Final exam of module</b>	End of lecture period	written exam or oral exam or practical work		
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Lecture		2.00	WiSe	28 h
Seminar or exercise		2.00	WiSe	28 h
<b>Total time of attendance for the module</b>				56 h

## inf300 - Hybrid Systems

<b>Module label</b>	Hybrid Systems
<b>Module code</b>	inf300
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Computing Science (Master) &gt; Theoretische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Embedded Brain Computer Interaction</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Systems Engineering</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Martin Georg Fränze</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Martin Georg Fränze</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	<p>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.</p>
<b>Skills to be acquired in this module</b>	<p>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.</p> <p><b>Professional competence</b> The students:</p> <ul style="list-style-type: none"> <li>• characterise formal models of cyber-physical systems: hybrid automata, hybrid state transition systems</li> <li>• name domain-specific system requirements: safety, stability, robustness</li> <li>• name analysis methods: symbolic state-space exploration, abstraction and abstraction refinement, generalized Lyapunov-Methods</li> <li>• use state-of-the-art analysis tools</li> <li>• select and apply adequate modelling and analysis methods for concrete application scenarios</li> <li>• apply methods to reduce large state spaces and reduce infinite-state systems by abstraction</li> <li>• know the de-facto industry standards for system modelling and are able to apply the corresponding modelling frameworks and tools</li> </ul> <p><b>Methodological competence</b> The students:</p> <ul style="list-style-type: none"> <li>• model heterogeneous dynamical systems with adequate modelling and design tools, in particular Simulink/Stateflow</li> <li>• transfer modelling and analysis methods to other heterogeneous domains, e.g. socio-technical systems</li> </ul> <p><b>Social competence</b> The students:</p> <ul style="list-style-type: none"> <li>• work in teams</li> <li>• solve complex modelling, design, and analysis tasks in teams</li> </ul> <p><b>Self-competence</b> The students:</p> <ul style="list-style-type: none"> <li>• reflect their actions and respect the scope of methods dedicated to hybrid systems</li> </ul>
<b>Module contents</b>	<p>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</p>

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

<b>Languages of instruction</b>	English , German			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>	once a year			
<b>Module capacity</b>	unlimited			
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)			
<b>Modulart</b>	Pflicht o. Wahlpflicht / compulsory or optioal			
<b>Lern-/Lehrform / Type of program</b>	V+Ü			
<b>Vorkenntnisse / Previous knowledge</b>	Bachelor in Computing Science oder Kenntnisse gewöhnlicher Differentialgleichungen			
<b>Examination</b>	Time of examination	Type of examination		
<b>Final exam of module</b>	At the end of the lecture period	Semester project including written work and final presentation		
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Lecture		3.00	SuSe	42 h
Exercises		1.00	SuSe	14 h
<b>Total time of attendance for the module</b>				<b>56 h</b>

## inf301 - Machine-oriented Systems Engineering

<b>Module label</b>	Machine-oriented Systems Engineering
<b>Module code</b>	inf301
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodulare</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Embedded Brain Computer Interaction</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Human-Computer Interaction</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Systems Engineering</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Alfred Mikschl</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Alfred Mikschl</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>The module provides practical relevance to the design of digital embedded systems.</p> <p><b>Professional competence</b> The students:</p> <ul style="list-style-type: none"> <li>• characterise the structure of microprocessor systems</li> <li>• name control aspects of time sensitive external components</li> <li>• program efficient embedded systems</li> </ul> <p><b>Methodological competence</b> The students:</p> <ul style="list-style-type: none"> <li>• use specifications from electrical components data sheets</li> </ul> <p><b>Social competence</b> The students:</p> <ul style="list-style-type: none"> <li>• work in a team</li> <li>• discuss solutions</li> </ul>
<b>Module contents</b>	<p>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.</p> <p>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.</p>
<b>Reader's advisory</b>	Lecturers notes, hardware manuals and data sheets, and development tool manuals
<b>Links</b>	
<b>Languages of instruction</b>	English , German
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	semi-annual
<b>Module capacity</b>	unlimited
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)
<b>Modulart</b>	Pflicht o. Wahlpflicht / compulsory or optioal
<b>Lern-/Lehrform / Type of program</b>	V+P
<b>Vorkenntnisse / Previous knowledge</b>	

Examination		Time of examination	Type of examination	
<b>Final exam of module</b>		At the end of the lecture period	Portfolio (Design, development and implementation of embedded systems, colloquium)	
Course type	Comment	SWS	Frequency	Workload attendance
Lecture		2.00	WiSe	28 h
Practical		2.00	WiSe	28 h
<b>Total time of attendance for the module</b>				<b>56 h</b>

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

<b>Module label</b>	Fuzzy Control and Artificial Neural Networks in Robotics and Automation
<b>Module code</b>	inf303
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Angewandte Informatik</li> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Embedded Brain Computer Interaction</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Human-Computer Interaction</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Systems Engineering</li> <li>• Master's Programme Engineering Physics (Master) &gt; Schwerpunkt: Renewable Energies</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Sergej Fatikow</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Sergej Fatikow</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>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 applications, 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.</p> <p><b>Professional competence</b> The students:</p> <ul style="list-style-type: none"> <li>• recognise control problems in robotics and automation technology,</li> <li>• name principles of fuzzy logic and ANN and their practical applications,</li> <li>• compare conventional and advanced control methods,</li> <li>• characterise the combination of fuzzy logic and ANN in control systems</li> </ul> <p><b>Methodological competence</b> The students:</p> <ul style="list-style-type: none"> <li>• will acquire knowledge of the tools, methods and applications in fuzzy logic and ANN</li> <li>• deepen their knowledge for the practical use of the given methods</li> <li>• can use common software tools for design and application of fuzzy logic and ANN</li> </ul> <p><b>Social competence</b> The students:</p> <ul style="list-style-type: none"> <li>• gain experience in interdisciplinary work</li> <li>• are integrated into the recent research work</li> </ul> <p>Objective of the module / skills:</p> <p><b>Self-competence</b> The students:</p> <ul style="list-style-type: none"> <li>• are able to transfer the gained knowledge for later use in their theses or studies for AMiR</li> <li>• can Design (complex) fuzzy logic controller and ANN systems</li> <li>• reflect their (control) solutions by using methods learned in this course</li> </ul>
<b>Module contents</b>	<ul style="list-style-type: none"> <li>• Control problems in robotics and automation technology</li> <li>• Basic ideas of fuzzy logic and ANN</li> </ul>

- 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, Systema 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
- Zalzal, 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

<b>Languages of instruction</b>	English , German	
<b>Duration (semesters)</b>	1 Semester	
<b>Module frequency</b>	once a year	
<b>Module capacity</b>	unlimited	
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)	
<b>Modulart</b>	Pflicht o. Wahlpflicht / compulsory or optioal	
<b>Lern-/Lehrform / Type of program</b>	V+Ü	
<b>Vorkenntnisse / Previous knowledge</b>	Regelungstechnik	
Examination	Time of examination	Type of examination
<b>Final exam of module</b>	At the end of the lecture period until the beginning	Hands-on-exercises and oral Exam

Examination		Time of examination of the next semester		Type of examination	
Course type	Comment	SWS		Frequency	Workload attendance
Lecture		3.00		SuSe	42 h
Exercises		1.00		SuSe	14 h
<b>Total time of attendance for the module</b>					<b>56 h</b>

## inf305 - Medical Technology

<b>Module label</b>	Medical Technology
<b>Module code</b>	inf305
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Nicht Informatik</li> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Embedded Brain Computer Interaction</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Human-Computer Interaction</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Systems Engineering</li> </ul>

<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Die im Modul Lehrenden</li> </ul>
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### Entry requirements

<b>Skills to be acquired in this module</b>	<p><b>Professional competence</b> The students:</p> <ul style="list-style-type: none"> <li>• Describe medical diagnosis and therapy methods</li> <li>• Understand the core concepts of computer-assisted medical interventions</li> <li>• Are aware of the basic concepts and legal conditions of the development of medical devices</li> <li>• Define the character of medical devices' software parts and implement them</li> <li>• Assess the complex interaction of medical products and patients</li> <li>• Get familiar with the development of medical products within a short period of time</li> </ul> <p><b>Methodological competence</b> The students:</p> <ul style="list-style-type: none"> <li>• Recognise the interdisciplinary challenges and accordingly exchange information with other disciplines</li> </ul> <p><b>Social competence</b> The students:</p> <ul style="list-style-type: none"> <li>• Present solutions for specific questions</li> </ul> <p><b>Self-competence</b> The students:</p> <ul style="list-style-type: none"> <li>• reflect their solutions by using methods learned in this course</li> </ul>
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<b>Module contents</b>	<ul style="list-style-type: none"> <li>• Medical areas and areas of application</li> <li>• Basic requirements for medical systems (hygiene, MPG, technical security, materials)</li> <li>• Medical systems: <ul style="list-style-type: none"> <li>• Functional diagnostics (ECG, EMG, EEG)</li> <li>• Imaging systems (CT, MRI, ultrasound, PET, SPECT) - Therapy equipment (Laser, RF, Microtherapy)</li> <li>• Signal processing / monitoring (cardiovascular, hemodynamic, respiratory, metabolic, cerebral)</li> <li>• Medical Informatics (HIS, DICOM, Telemedicine, VR, image processing).</li> </ul> </li> </ul>
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<b>Reader's advisory</b>	<p><b>essential:</b></p> <ul style="list-style-type: none"> <li>• Kramme, R.: Medizintechnik. Verfahren, Systeme und Informationssysteme. Springer Verlag, 2002 (2. Auflage)</li> <li>• Lecture slides</li> </ul> <p><b>recommended:</b></p>
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- Lehmann, Th.; Oberschelp, W.; Pelikan, E.; Peppes, 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

<b>Links</b>				
<b>Languages of instruction</b>		English , German		
<b>Duration (semesters)</b>		1 Semester		
<b>Module frequency</b>		once a year		
<b>Module capacity</b>		unlimited		
<b>Modullevel</b>		AS (Akzentsetzung / Accentuation)		
<b>Modulart</b>		Pflicht o. Wahlpflicht / compulsory or optioal		
<b>Lern-/Lehrform / Type of program</b>		V+Ü		
<b>Vorkenntnisse / Previous knowledge</b>		- Signal und Bildverarbeitung - Regelungstechnik		
<b>Examination</b>		Time of examination		Type of examination
<b>Final exam of module</b>		At the end of the lecture periode		Portfolio: Hands-on exercises, report, and written or oral exam
Course type	Comment	SWS	Frequency	Workload attendance
Lecture		3.00	WiSe	42 h
Exercises		1.00	WiSe	14 h
<b>Total time of attendance for the module</b>				56 h

## inf307 - Robotics

<b>Module label</b>	Robotics
<b>Module code</b>	inf307
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Nicht Informatik</li> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Embedded Brain Computer Interaction</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Human-Computer Interaction</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Systems Engineering</li> </ul>

<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Die im Modul Lehrenden</li> <li>◦ Andreas Hein</li> </ul>
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### Entry requirements

<b>Skills to be acquired in this module</b>	<p><b>Professional competence</b> The students:</p> <ul style="list-style-type: none"> <li>• Name and know the functions and applications of robot systems</li> <li>• Characterise the basic concepts to program robot systems</li> <li>• Differentiate between the interaction of mechanical, electrical and software components</li> </ul> <p><b>Methodological competence</b> The students:</p> <ul style="list-style-type: none"> <li>• Define characteristics and components of robot systems for a specific application</li> <li>• Design and implement robot system sub-components</li> <li>• Design and parameterise simple control structures</li> <li>• Plan the application of robot systems and derive the requirements</li> <li>• Model electrical and mechanical systems</li> <li>• Develop and realise simple robot systems</li> </ul> <p><b>Social competence</b> The students:</p> <ul style="list-style-type: none"> <li>• Solve robot systems problems in team work</li> </ul> <p><b>Self-competence</b> The students:</p> <ul style="list-style-type: none"> <li>• Reflect their solutions in reference to robot system methods</li> </ul>
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### 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

<b>Reader's advisory</b>	<p><b>essential:</b> lecture nodes</p> <p><b>recommended:</b> Lüth, T.: Technische Multi-Agenten-Systeme. 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.</p> <p><b>sekondary literature:</b> 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.</p>			
<b>Links</b>				
<b>Languages of instruction</b>	German, English			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>	once a year			
<b>Module capacity</b>	unlimited			
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)			
<b>Modulart</b>	Pflicht o. Wahlpflicht / compulsory or optioal			
<b>Lern-/Lehrform / Type of program</b>	V+Ü			
<b>Vorkenntnisse / Previous knowledge</b>				
Examination	Time of examination		Type of examination	
<b>Final exam of module</b>	At the end of the lecture periode		Portfolio: Hands-on exercises, report, and written or oral exam	
Course type	Comment	SWS	Frequency	Workload attendance
Lecture		3.00	SuSe	42 h
Exercises		1.00	SuSe	14 h
<b>Total time of attendance for the module</b>				56 h

## inf308 - Microrobotics II

<b>Module label</b>	Microrobotics II
<b>Module code</b>	inf308
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Nicht Informatik</li> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Embedded Brain Computer Interaction</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Human-Computer Interaction</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Systems Engineering</li> <li>• Master's Programme Engineering Physics (Master) &gt; Schwerpunkt: Laser and Optics</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Sergej Fatikow</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Sergej Fatikow</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>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.</p> <p><b>Professional competence</b> The students:</p> <ul style="list-style-type: none"> <li>• name and recognise the basic concepts of nanotechnology, in particular, micro- and nanorobotics approaches</li> <li>• differentiate the development, control and application of micro- and nanorobotics systems</li> <li>• implement and design application-specific micro- and nanorobotics systems</li> </ul> <p><b>Methodological competence</b> The students:</p> <ul style="list-style-type: none"> <li>• transfer their control engineering and image processing abilities on interdisciplinary problems</li> <li>• transfer their hands-on experience to develop controls and applications of microrobotic systems on new tasks</li> </ul> <p><b>Social competence</b> The students:</p> <ul style="list-style-type: none"> <li>• work in a team</li> </ul> <p><b>Self-competence</b> The students:</p> <ul style="list-style-type: none"> <li>• reflect their problem-solving behaviour and use hands-on experience to develop, control and application of microrobotics</li> </ul>
<b>Module contents</b>	<p>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</p>
<b>Reader's advisory</b>	<ul style="list-style-type: none"> <li>• Lecture notes (can be obtained in secretariate, A1-3-303)</li> </ul>

- Fatikow, Sergej (Ed.): Automated Nanohandling by Microrobots, Springer, London, 2008

<b>Links</b>				
<b>Languages of instruction</b>		English , German		
<b>Duration (semesters)</b>		1 Semester		
<b>Module frequency</b>		once a year		
<b>Module capacity</b>		unlimited		
<b>Modullevel</b>		AS (Akzentsetzung / Accentuation)		
<b>Modulart</b>		Pflicht o. Wahlpflicht / compulsory or optioal		
<b>Lern-/Lehrform / Type of program</b>		V+Ü		
<b>Vorkenntnisse / Previous knowledge</b>		Mikrorobotik und Mikrosystemtechnik		
<b>Examination</b>		Time of examination		Type of examination
<b>Final exam of module</b>		At the end of the lecture period		Oral Exam and exercises
Course type	Comment	SWS	Frequency	Workload attendance
Lecture		3.00	SuSe	42 h
Exercises		1.00	SuSe	14 h
<b>Total time of attendance for the module</b>				56 h

## inf311 - Low Energy System Design

<b>Module label</b>	Low Energy System Design
<b>Module code</b>	inf311
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Embedded Brain Computer Interaction</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Systems Engineering</li> </ul>

<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Wolfgang Nebel</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Die im Modul Lehrenden</li> <li>◦ Wolfgang Nebel</li> </ul>
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### Entry requirements

<b>Skills to be acquired in this module</b>	This module introduces the estimation of power dissipation and optimisation.
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#### 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

<b>Module contents</b>	<p>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.</p>
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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.

<b>Reader's advisory</b>	<ul style="list-style-type: none"> <li>• Designing CMOS Circuits for Low Power – Dimitros Soudris, Christian Piguët, Costas Goutis</li> <li>• Low-Power CMOS VLSI Circuit Design – Kaushik Roy, Sharat C. Prasad</li> </ul>
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- Low-Power Electronics Design – Christian Pigué 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

<b>Links</b>				
<b>Languages of instruction</b>		English , German		
<b>Duration (semesters)</b>		1 Semester		
<b>Module frequency</b>		jährlich		
<b>Module capacity</b>		unlimited		
<b>Modullevel</b>		AS (Akzentsetzung / Accentuation)		
<b>Modulart</b>		Pflicht o. Wahlpflicht / compulsory or optional		
<b>Lern-/Lehrform / Type of program</b>		V+Ü		
<b>Vorkenntnisse / Previous knowledge</b>		- inf200 Grundlagen der Technische Informatik, - inf201 Technische Informatik, - inf203 Eingebettete Systeme I+II, - inf204 Eingebettete Systeme II		
<b>Examination</b>		<b>Time of examination</b>		<b>Type of examination</b>
<b>Final exam of module</b>		at the end of the lecture period		hands-on exercises and oral exam
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Lecture		2.00	WiSe	28 h
Exercises		2.00	WiSe	28 h
<b>Total time of attendance for the module</b>				<b>56 h</b>

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

<b>Module label</b>	Special Topics in 'Safety-Critical Systems' I
<b>Module code</b>	inf350
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>This module integrates current developments in the field in adequate study courses.</p> <p><b>Professional competences</b> The students:</p> <ul style="list-style-type: none"> <li>• define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general</li> <li>• recognise and evaluate applied techniques and methods of their subject and are aware of their limits</li> <li>• identify, structure and solve problems/tasks, also in new or developing subject areas</li> <li>• apply state of the art and innovative methods to solve problems, if necessary from other disciplines</li> <li>• are aware of the current limits and contribute to the development of computer science research and technology</li> <li>• discuss and evaluate recent computer science developments</li> </ul> <p><b>Methodological competences</b> The students:</p> <ul style="list-style-type: none"> <li>• evaluate and apply tools, technology and methods sophisticatedly</li> <li>• combine new and original approaches and methods creatively</li> <li>• evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</li> </ul> <p><b>Social competences</b> The students:</p> <ul style="list-style-type: none"> <li>• support team process by their abilities</li> </ul> <p><b>Self-competences</b> The students:</p> <ul style="list-style-type: none"> <li>• pursue the overall and special computer science development critically</li> <li>• implement innovative professional activities effectively and independently</li> </ul>
<b>Module contents</b>	See assigned course description, e.g. „Sicherheitsanalysetechniken“, „Zielarchitekturen Eingebetteter Systeme für Automotive-Anwendungen“, „Modellbasierter Systementwurf“, ...
<b>Reader's advisory</b>	As announced in course
<b>Links</b>	
<b>Language of instruction</b>	German
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	unregelmäßig
<b>Module capacity</b>	unlimited
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht
<b>Lern-/Lehrform / Type of program</b>	2 Verant. aus V, Ü, S, P, PR (4SWS)
<b>Vorkenntnisse / Previous knowledge</b>	

Examination	Time of examination	Type of examination
<b>Final exam of module</b>		Portfolio or presentation or oral exam
<b>Course type</b>	VA-Auswahl	
<b>SWS</b>	4.00	
<b>Frequency</b>	SuSe or WiSe	
<b>Workload attendance</b>	56 h	

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

<b>Module label</b>	Special Topics in 'Safety-Critical Systems' II
<b>Module code</b>	inf351
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>This module integrates current developments in the field in adequate study courses.</p> <p><b>Professional competences</b> The students:</p> <ul style="list-style-type: none"> <li>• define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general</li> <li>• recognise and evaluate applied techniques and methods of their subject and are aware of their limits</li> <li>• identify, structure and solve problems/tasks, also in new or developing subject areas</li> <li>• apply state of the art and innovative methods to solve problems, if necessary from other disciplines</li> <li>• are aware of the current limits and contribute to the development of computer science research and technology</li> <li>• discuss and evaluate recent computer science developments</li> </ul> <p><b>Methodological competences</b> The students:</p> <ul style="list-style-type: none"> <li>• evaluate and apply tools, technology and methods sophisticatedly</li> <li>• combine new and original approaches and methods creatively</li> <li>• evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</li> </ul> <p><b>Social competences</b> The students:</p> <ul style="list-style-type: none"> <li>• support team process by their abilities</li> </ul> <p><b>Self-competences</b> The students:</p> <ul style="list-style-type: none"> <li>• pursue the overall and special computer science development critically</li> <li>• implement innovative professional activities effectively and independently</li> </ul>
<b>Module contents</b>	See assigned course description, e.g. „Sicherheitsanalysetechniken“, „Modellbasierter Systementwurf“, ...
<b>Reader's advisory</b>	As announced in course
<b>Links</b>	
<b>Language of instruction</b>	German
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	halbjährlich
<b>Module capacity</b>	unlimited
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht
<b>Lern-/Lehrform / Type of program</b>	2 Verant. aus V, S, Ü, P, PR (4SWS)
<b>Vorkenntnisse / Previous knowledge</b>	

Examination	Time of examination	Type of examination
<b>Final exam of module</b>		Portfolio or presentation or oral exam
<b>Course type</b>	VA-Auswahl	
<b>SWS</b>	4.00	
<b>Frequency</b>	SuSe or WiSe	
<b>Workload attendance</b>	56 h	

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

<b>Module label</b>	Current Topics in 'Safety-Critical Systems' I
<b>Module code</b>	inf352
<b>Credit points</b>	3.0 KP
<b>Workload</b>	90 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>This module integrates current developments in the field in adequate study courses.</p> <p><b>Professional competences</b> The students:</p> <ul style="list-style-type: none"> <li>• define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general</li> <li>• recognise and evaluate applied techniques and methods of their subject and are aware of their limits</li> <li>• identify, structure and solve problems/tasks, also in new or developing subject areas</li> <li>• apply state of the art and innovative methods to solve problems, if necessary from other disciplines</li> <li>• are aware of the current limits and contribute to the development of computer science research and technology</li> <li>• discuss and evaluate recent computer science developments</li> </ul> <p><b>Methodological competences</b> The students:</p> <ul style="list-style-type: none"> <li>• examine tasks with technical and research literature, write an academic article and present their solutions academically</li> <li>• evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</li> <li>• schedule time processes and resources</li> </ul> <p><b>Social competences</b> The students:</p> <ul style="list-style-type: none"> <li>• communicate with users and experts convincingly</li> </ul> <p><b>Self-competences</b> The students:</p> <ul style="list-style-type: none"> <li>• pursue the overall and special computer science development critically</li> <li>• develop and reflect self-developed hypotheses to theories independently</li> </ul>
<b>Module contents</b>	See assigned course description
<b>Reader's advisory</b>	As announced in course
<b>Links</b>	
<b>Language of instruction</b>	German
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	unregelmäßig
<b>Module capacity</b>	unlimited
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht
<b>Lern-/Lehrform / Type of program</b>	S oder V (2 SWS)

**Vorkenntnisse / Previous knowledge**

Examination	Time of examination	Type of examination
<b>Final exam of module</b>	At the end of the lecture period	Presentation or oral exam
<b>Course type</b>	Course or seminar	
<b>SWS</b>	2.00	
<b>Frequency</b>	SuSe or WiSe	
<b>Workload attendance</b>	28 h	

## inf353 - CurrentTopics in 'Safety-Critical Systems' II

<b>Module label</b>	CurrentTopics in 'Safety-Critical Systems' II
<b>Module code</b>	inf353
<b>Credit points</b>	3.0 KP
<b>Workload</b>	90 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>This module integrates current developments in the field in adequate study courses.</p> <p><b>Professional competences</b> The students:</p> <ul style="list-style-type: none"> <li>• define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general</li> <li>• recognise and evaluate applied techniques and methods of their subject and are aware of their limits</li> <li>• identify, structure and solve problems/tasks, also in new or developing subject areas</li> <li>• apply state of the art and innovative methods to solve problems, if necessary from other disciplines</li> <li>• are aware of the current limits and contribute to the development of computer science research and technology</li> <li>• discuss and evaluate recent computer science developments</li> </ul> <p><b>Methodological competences</b> The students:</p> <ul style="list-style-type: none"> <li>• examine tasks with technical and research literature, write an academic article and present their solutions academically</li> <li>• evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</li> <li>• schedule time processes and resources</li> </ul> <p><b>Social competences</b> The students:</p> <ul style="list-style-type: none"> <li>• communicate with users and experts convincingly</li> </ul> <p><b>self-competences</b> The students:</p> <ul style="list-style-type: none"> <li>• pursue the overall and special computer science development critically</li> <li>• develop and reflect self-developed hypotheses to theories independently</li> </ul>
<b>Module contents</b>	See assigned course description
<b>Reader's advisory</b>	As announced in course
<b>Links</b>	
<b>Languages of instruction</b>	German, English
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	unregelmäßig
<b>Module capacity</b>	unlimited
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht
<b>Lern-/Lehrform / Type of program</b>	S oder V (2SWS)

**Vorkenntnisse / Previous knowledge**

Examination	Time of examination	Type of examination
<b>Final exam of module</b>	At the end of the lecture period	Presentation or oral exam
<b>Course type</b>	Course or seminar	
<b>SWS</b>	2.00	
<b>Frequency</b>	WiSe	
<b>Workload attendance</b>	28 h	

## inf354 - Special Topics in 'Hybrid Systems' I

<b>Module label</b>	Special Topics in 'Hybrid Systems' I
<b>Module code</b>	inf354
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Martin Georg Fränzle</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Martin Georg Fränzle</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>This module integrates current developments in the field in adequate study courses.</p> <p><b>Professional competences</b> The students:</p> <ul style="list-style-type: none"> <li>• define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general</li> <li>• recognise and evaluate applied techniques and methods of their subject and are aware of their limits</li> <li>• identify, structure and solve problems/tasks, also in new or developing subject areas</li> <li>• apply state of the art and innovative methods to solve problems, if necessary from other disciplines</li> <li>• are aware of the current limits and contribute to the development of computer science research and technology</li> <li>• discuss and evaluate recent computer science developments</li> </ul> <p><b>Methodological competences</b> The students:</p> <ul style="list-style-type: none"> <li>• evaluate and apply tools, technology and methods sophisticatedly</li> <li>• combine new and original approaches and methods creatively</li> <li>• evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</li> </ul> <p><b>Social competences</b> The students:</p> <ul style="list-style-type: none"> <li>• support team process by their abilities</li> </ul> <p><b>self-competences</b> The students:</p> <ul style="list-style-type: none"> <li>• pursue the overall and special computer science development critically</li> <li>• implement innovative professional activities effectively and independently</li> </ul>
<b>Module contents</b>	See assigned course description, e.g. „Modellbasierter Systementwurf“, „Konstruktionsprinzipien ausgewählter Klassen von Fahrzeugfunktionen“
<b>Reader's advisory</b>	As announced in course
<b>Links</b>	
<b>Language of instruction</b>	German
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	halbjährlich
<b>Module capacity</b>	unlimited
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht

**Lern-/Lehrform / Type of program** 2 Veranst. aus V, Ü, S, P, PR (4SWS)

**Vorkenntnisse / Previous knowledge**

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

**Course type** VA-Auswahl

**SWS** 2.00

**Frequency** SuSe or WiSe

**Workload attendance** 28 h

## inf355 - Special Topics in 'Hybrid Systems' II

<b>Module label</b>	Special Topics in 'Hybrid Systems' II
<b>Module code</b>	inf355
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Martin Georg Fränzle</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Martin Georg Fränzle</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>This module integrates current developments in the field in adequate study courses.</p> <p><b>Professional competences</b> The students:</p> <ul style="list-style-type: none"> <li>• define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general</li> <li>• recognise and evaluate applied techniques and methods of their subject and are aware of their limits</li> <li>• identify, structure and solve problems/tasks, also in new or developing subject areas</li> <li>• apply state of the art and innovative methods to solve problems, if necessary from other disciplines</li> <li>• are aware of the current limits and contribute to the development of computer science research and technology</li> <li>• discuss and evaluate recent computer science developments</li> </ul> <p><b>Methodological competences</b> The students:</p> <ul style="list-style-type: none"> <li>• evaluate and apply tools, technology and methods sophisticatedly</li> <li>• combine new and original approaches and methods creatively</li> <li>• evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</li> </ul> <p><b>Social competences</b> The students:</p> <ul style="list-style-type: none"> <li>• support team process by their abilities</li> </ul> <p><b>Self-competences</b> The students:</p> <ul style="list-style-type: none"> <li>• pursue the overall and special computer science development critically</li> <li>• implement innovative professional activities effectively and independently</li> </ul>
<b>Module contents</b>	See assigned course description
<b>Reader's advisory</b>	As announced in course
<b>Links</b>	
<b>Language of instruction</b>	German
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	unregelmäßig
<b>Module capacity</b>	unlimited
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht

**Lern-/Lehrform / Type of program** 2 Veranst. aus V, Ü, S, P, PR (4SWS)

**Vorkenntnisse / Previous knowledge**

Examination	Time of examination	Type of examination
<b>Final exam of module</b>	At the end of the lecture period	Exercises or presentation or oral exam
<b>Course type</b>	VA-Auswahl	
<b>SWS</b>	2.00	
<b>Frequency</b>	SuSe or WiSe	
<b>Workload attendance</b>	28 h	

## inf356 - CurrentTopics in 'Hybrid Systems' I

<b>Module label</b>	CurrentTopics in 'Hybrid Systems' I
<b>Module code</b>	inf356
<b>Credit points</b>	3.0 KP
<b>Workload</b>	90 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Martin Georg Fränzle</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Martin Georg Fränzle</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>This module integrates current developments in the field in adequate study courses.</p> <p><b>Professional competences</b> The students:</p> <ul style="list-style-type: none"> <li>• define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general</li> <li>• recognise and evaluate applied techniques and methods of their subject and are aware of their limits</li> <li>• identify, structure and solve problems/tasks, also in new or developing subject areas</li> <li>• apply state of the art and innovative methods to solve problems, if necessary from other disciplines</li> <li>• are aware of the current limits and contribute to the development of computer science research and technology</li> <li>• discuss and evaluate recent computer science developments</li> </ul> <p><b>Methodological competences</b> The students:</p> <ul style="list-style-type: none"> <li>• examine tasks with technical and research literature, write an academic article and present their solutions academically</li> <li>• evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</li> <li>• schedule time processes and resources</li> </ul> <p><b>Social competences</b> The students:</p> <ul style="list-style-type: none"> <li>• communicate with users and experts convincingly</li> </ul> <p><b>Self-competences</b> The students:</p> <ul style="list-style-type: none"> <li>• pursue the overall and special computer science development critically</li> <li>• develop and reflect self-developed hypotheses to theories independently</li> </ul>
<b>Module contents</b>	See assigned course description
<b>Reader's advisory</b>	As announced in course
<b>Links</b>	
<b>Languages of instruction</b>	German, English
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	unregelmäßig
<b>Module capacity</b>	unlimited
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht

<b>Lern-/Lehrform / Type of program</b>	S oder V (2SWS)	
<b>Vorkenntnisse / Previous knowledge</b>		
Examination	Time of examination	Type of examination
<b>Final exam of module</b>	At the end of the lecture period	Presentation or oral exam
<b>Course type</b>	Course or seminar	
<b>SWS</b>	2.00	
<b>Frequency</b>	SuSe or WiSe	
<b>Workload attendance</b>	28 h	

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

<b>Module label</b>	Aktuelle Themen aus dem Gebiet "Hybride Systeme" II
<b>Module code</b>	inf357
<b>Credit points</b>	3.0 KP
<b>Workload</b>	90 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Martin Georg Fränze</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Martin Georg Fränze</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>This module integrates current developments in the field in adequate study courses.</p> <p><b>Professional competences</b> The students:</p> <ul style="list-style-type: none"> <li>• define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general</li> <li>• recognise and evaluate applied techniques and methods of their subject and are aware of their limits</li> <li>• identify, structure and solve problems/tasks, also in new or developing subject areas</li> <li>• apply state of the art and innovative methods to solve problems, if necessary from other disciplines</li> <li>• are aware of the current limits and contribute to the development of computer science research and technology</li> <li>• discuss and evaluate recent computer science developments</li> </ul> <p><b>Methodological competences</b> The students:</p> <ul style="list-style-type: none"> <li>• examine tasks with technical and research literature, write an academic article and present their solutions academically</li> <li>• evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</li> <li>• schedule time processes and resources</li> </ul> <p><b>Social competences</b> The students:</p> <ul style="list-style-type: none"> <li>• communicate with users and experts convincingly</li> </ul> <p><b>Self-competences</b> The students:</p> <ul style="list-style-type: none"> <li>• pursue the overall and special computer science development critically</li> <li>• develop and reflect self-developed hypotheses to theories independently</li> </ul>
<b>Module contents</b>	See assigned course description
<b>Reader's advisory</b>	As announced in course
<b>Links</b>	
<b>Language of instruction</b>	German
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	unregelmäßig
<b>Module capacity</b>	unlimited
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht

<b>Lern-/Lehrform / Type of program</b>	S oder V (2SWS)	
<b>Vorkenntnisse / Previous knowledge</b>		
Examination	Time of examination	Type of examination
<b>Final exam of module</b>	At the end of the lecture period	Presentation or oral exam
<b>Course type</b>	Course or seminar	
<b>SWS</b>	2.00	
<b>Frequency</b>	WiSe	
<b>Workload attendance</b>	28 h	

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

<b>Module label</b>	Special Topics in 'Hardware/Software Systems' I
<b>Module code</b>	inf358
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Wolfgang Nebel</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Wolfgang Nebel</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>This module integrates current developments in the field in adequate study courses.</p> <p><b>Professional competences</b> The students:</p> <ul style="list-style-type: none"> <li>• define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general</li> <li>• recognise and evaluate applied techniques and methods of their subject and are aware of their limits</li> <li>• identify, structure and solve problems/tasks, also in new or developing subject areas</li> <li>• apply state of the art and innovative methods to solve problems, if necessary from other disciplines</li> <li>• are aware of the current limits and contribute to the development of computer science research and technology</li> <li>• discuss and evaluate recent computer science developments</li> </ul> <p><b>Methodological competences</b> The students:</p> <ul style="list-style-type: none"> <li>• evaluate and apply tools, technology and methods sophisticatedly</li> <li>• combine new and original approaches and methods creatively</li> <li>• evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</li> </ul> <p><b>Social competences</b> The students:</p> <ul style="list-style-type: none"> <li>• support team process by their abilities</li> </ul> <p><b>Self-competences</b> The students:</p> <ul style="list-style-type: none"> <li>• pursue the overall and special computer science development critically</li> <li>• implement innovative professional activities effectively and independently</li> </ul>
<b>Module contents</b>	See assigned course description, e.g. „Spezifikation und Modellierung Eingebetteter Systeme“
<b>Reader's advisory</b>	As announced in course
<b>Links</b>	
<b>Language of instruction</b>	German
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	halbjährlich
<b>Module capacity</b>	unlimited
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht

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<b>Lern-/Lehrform / Type of program</b>	2 Veranst. aus V, Ü, S, P, PR (4SWS)	
<b>Vorkenntnisse / Previous knowledge</b>		
Examination	Time of examination	Type of examination
<b>Final exam of module</b>	The exam period will be announced during the course	Portfolio or presentation or oral exam
<b>Course type</b>	VA-Auswahl	
<b>SWS</b>	2.00	
<b>Frequency</b>	SuSe or WiSe	
<b>Workload attendance</b>	28 h	

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

<b>Module label</b>	Spezielle Themen aus dem Gebiet "Hardware-/Software-Systeme" II
<b>Module code</b>	inf359
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Wolfgang Nebel</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Wolfgang Nebel</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>This module integrates current developments in the field in adequate study courses.</p> <p><b>Professional competences</b> The students:</p> <ul style="list-style-type: none"> <li>• define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general</li> <li>• recognise and evaluate applied techniques and methods of their subject and are aware of their limits</li> <li>• identify, structure and solve problems/tasks, also in new or developing subject areas</li> <li>• apply state of the art and innovative methods to solve problems, if necessary from other disciplines</li> <li>• are aware of the current limits and contribute to the development of computer science research and technology</li> <li>• discuss and evaluate recent computer science developments</li> </ul> <p><b>Methodological competences</b> The students:</p> <ul style="list-style-type: none"> <li>• evaluate and apply tools, technology and methods sophisticatedly</li> <li>• combine new and original approaches and methods creatively</li> <li>• evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</li> </ul> <p><b>Social competences</b> The students:</p> <ul style="list-style-type: none"> <li>• support team process by their abilities</li> </ul> <p><b>Self-competences</b> The students:</p> <ul style="list-style-type: none"> <li>• pursue the overall and special computer science development critically</li> <li>• implement innovative professional activities effectively and independently</li> </ul>
<b>Module contents</b>	See assigned course description, e.g. „Spezifikation und Modellierung Eingebetteter Systeme“
<b>Reader's advisory</b>	As announced in course
<b>Links</b>	
<b>Language of instruction</b>	German
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	unregelmäßig
<b>Module capacity</b>	unlimited
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht

<b>Lern-/Lehrform / Type of program</b>	2 Veranst. aus V, Ü, S, P, PR (4SWS)	
<b>Vorkenntnisse / Previous knowledge</b>		
Examination	Time of examination	Type of examination
<b>Final exam of module</b>	The exam period will be announced during the course	Exercises or presentation or oral exam
<b>Course type</b>	VA-Auswahl	
<b>SWS</b>	2.00	
<b>Frequency</b>	WiSe	
<b>Workload attendance</b>	28 h	

## inf360 - CurrentTopics in 'Hardware/Software Systems' I

<b>Module label</b>	CurrentTopics in 'Hardware/Software Systems' I
<b>Module code</b>	inf360
<b>Credit points</b>	3.0 KP
<b>Workload</b>	90 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Wolfgang Nebel</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Wolfgang Nebel</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>This module integrates current developments in the field in adequate study courses.</p> <p>Professional competences The students:</p> <ul style="list-style-type: none"> <li>• Define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general</li> <li>• Recognise and evaluate applied techniques and methods of their subject and are aware of their limits</li> <li>• Identify, structure and solve problems/tasks, also in new or developing subject areas</li> <li>• Apply state of the art and innovative methods to solve problems, if necessary from other disciplines</li> <li>• Are aware of the current limits and contribute to the development of computer science research and technology</li> <li>• Discuss and evaluate recent computer science developments</li> </ul> <p>Methodological competences The students:</p> <ul style="list-style-type: none"> <li>• Examine tasks with technical and research literature, write an academic article and present their solutions academically</li> <li>• Evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</li> <li>• Schedule time processes and resources</li> </ul> <p>Social competences The students:</p> <ul style="list-style-type: none"> <li>• Communicate with users and experts convincingly</li> </ul> <p>Self-competences The students:</p> <ul style="list-style-type: none"> <li>• Pursue the overall and special computer science development critically</li> <li>• Develop and reflect self-developed hypotheses to theories independently</li> </ul>
<b>Module contents</b>	See assigned course description, e.g. „Energieeffizienz in der IKT“, „Smart Resource Integration“, ...
<b>Reader's advisory</b>	As announced in course
<b>Links</b>	
<b>Language of instruction</b>	German
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	unregelmäßig
<b>Module capacity</b>	unlimited
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht

<b>Lern-/Lehrform / Type of program</b>	S oder V (2SWS)	
<b>Vorkenntnisse / Previous knowledge</b>		
Examination	Time of examination	Type of examination
<b>Final exam of module</b>	At the end of the lecture period	Presentation or oral exam
<b>Course type</b>	VA-Auswahl	
<b>SWS</b>	2.00	
<b>Frequency</b>	SuSe or WiSe	
<b>Workload attendance</b>	28 h	

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

<b>Module label</b>	Current Topics in 'Hardware/Software Systems' II
<b>Module code</b>	inf361
<b>Credit points</b>	3.0 KP
<b>Workload</b>	90 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Wolfgang Nebel</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Wolfgang Nebel</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>This module integrates current developments in the field in adequate study courses.</p> <p><b>Professional competences</b> The students:</p> <ul style="list-style-type: none"> <li>• define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general</li> <li>• recognise and evaluate applied techniques and methods of their subject and are aware of their limits</li> <li>• identify, structure and solve problems/tasks, also in new or developing subject areas</li> <li>• apply state of the art and innovative methods to solve problems, if necessary from other disciplines</li> <li>• are aware of the current limits and contribute to the development of computer science research and technology</li> <li>• discuss and evaluate recent computer science developments</li> </ul> <p><b>Methodological competences</b> The students:</p> <ul style="list-style-type: none"> <li>• examine tasks with technical and research literature, write an academic article and present their solutions academically</li> <li>• evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</li> <li>• echedule time processes and resources</li> </ul> <p><b>Social competences</b> The students:</p> <ul style="list-style-type: none"> <li>• communicate with users and experts convincingly</li> </ul> <p><b>Self-competences</b> The students:</p> <ul style="list-style-type: none"> <li>• pursue the overall and special computer science development critically</li> <li>• develop and reflect self-developed hypotheses to theories independently</li> </ul>
<b>Module contents</b>	See assigned course description, e.g. „Energieeffizienz in der IKT“, „Smart Resource Integration“, ...
<b>Reader's advisory</b>	As announced in course
<b>Links</b>	
<b>Language of instruction</b>	German
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	unregelmäßig
<b>Module capacity</b>	unlimited
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht

<b>Lern-/Lehrform / Type of program</b>	S oder V (2 SWS)	
<b>Vorkenntnisse / Previous knowledge</b>		
Examination	Time of examination	Type of examination
<b>Final exam of module</b>	At the end of the lecture period	As announced in the according course
<b>Course type</b>	Course or seminar	
<b>SWS</b>	2.00	
<b>Frequency</b>	SuSe or WiSe	
<b>Workload attendance</b>	28 h	

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

<b>Module label</b>	Special Topics in 'Microrobotics and Control Engineering' I
<b>Module code</b>	inf366
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Sergej Fatikow</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Sergej Fatikow</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	This module integrates current developments in the field in adequate study courses.
	<p><b>Professional competences</b> <b>The students:</b></p> <ul style="list-style-type: none"> <li>• <b>define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general</b></li> <li>• <b>recognise and evaluate applied techniques and methods of their subject and are aware of their limits</b></li> <li>• <b>identify, structure and solve problems/tasks, also in new or developing subject areas</b></li> <li>• <b>apply state of the art and innovative methods to solve problems, if necessary from other disciplines</b></li> <li>• <b>are aware of the current limits and contribute to the development of computer science research and technology</b></li> <li>• <b>discuss and evaluate recent computer science developments</b></li> </ul> <p>Methodological competences <b>The students:</b></p> <ul style="list-style-type: none"> <li>• <b>evaluate and apply tools, technology and methods sophisticatedly</b></li> <li>• <b>combine new and original approaches and methods creatively</b></li> <li>• <b>evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</b></li> </ul> <p>Social competences <b>The students:</b></p> <ul style="list-style-type: none"> <li>• <b>support team process by their abilities</b></li> </ul> <p>Self-competences** <b>The students:</b></p> <ul style="list-style-type: none"> <li>• <b>pursue the overall and special computer science development critically</b></li> <li>• <b>implement innovative professional activities effectively and independently</b></li> </ul>
<b>Module contents</b>	See assigned course description, e.g. „Nanomontage und Nanohandhabung“
<b>Reader's advisory</b>	As announced in course
<b>Links</b>	
<b>Language of instruction</b>	German
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	jährlich
<b>Module capacity</b>	unlimited

<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)	
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht	
<b>Lern-/Lehrform / Type of program</b>	2 Verant. aus V, S, Ü, P, PR (4SWS)	
<b>Vorkenntnisse / Previous knowledge</b>		
Examination	Time of examination	Type of examination
<b>Final exam of module</b>	The exam period will be announced during the course	Portfolio or presentation or oral exam
<b>Course type</b>	VA-Auswahl	
<b>SWS</b>	2.00	
<b>Frequency</b>	SuSe or WiSe	
<b>Workload attendance</b>	28 h	

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

<b>Module label</b>	Spezielle Themen aus dem Gebiet "Mikrorobotik und Regelungstechnik" II
<b>Module code</b>	inf367
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Sergej Fatikow</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Sergej Fatikow</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>This module integrates current developments in the field in adequate study courses.</p> <p><b>Professional competences</b> The students:</p> <ul style="list-style-type: none"> <li>• define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general</li> <li>• recognise and evaluate applied techniques and methods of their subject and are aware of their limits</li> <li>• identify, structure and solve problems/tasks, also in new or developing subject areas</li> <li>• apply state of the art and innovative methods to solve problems, if necessary from other disciplines</li> <li>• are aware of the current limits and contribute to the development of computer science research and technology</li> <li>• discuss and evaluate recent computer science developments</li> </ul> <p><b>Methodological competences</b> The students:</p> <ul style="list-style-type: none"> <li>• evaluate and apply tools, technology and methods sophisticatedly</li> <li>• combine new and original approaches and methods creatively</li> <li>• evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</li> </ul> <p><b>Social competences</b> The students:</p> <ul style="list-style-type: none"> <li>• support team process by their abilities</li> </ul> <p><b>Self-competences</b> The students:</p> <ul style="list-style-type: none"> <li>• pursue the overall and special computer science development critically</li> <li>• implement innovative professional activities effectively and independently</li> </ul>
<b>Module contents</b>	See assigned course description
<b>Reader's advisory</b>	As announced in course
<b>Links</b>	
<b>Language of instruction</b>	German
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	unregelmäßig
<b>Module capacity</b>	unlimited
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht

<b>Lern-/Lehrform / Type of program</b>	2 Veranst. aus V, Ü, S, P, PR (4SWS)	
<b>Vorkenntnisse / Previous knowledge</b>		
Examination	Time of examination	Type of examination
<b>Final exam of module</b>	The exam period will be announced during the course	Portfolio or presentation or oral exam
<b>Course type</b>	VA-Auswahl	
<b>SWS</b>	2.00	
<b>Frequency</b>	SuSe or WiSe	
<b>Workload attendance</b>	28 h	

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

<b>Module label</b>	Aktuelle Themen aus dem Gebiet "Mikrorobotik und Regelungstechnik" I
<b>Module code</b>	inf368
<b>Credit points</b>	3.0 KP
<b>Workload</b>	90 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Sergej Fatikow</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Sergej Fatikow</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>This module integrates current developments in the field in adequate study courses.</p> <p><b>Professional competences</b> The students:</p> <ul style="list-style-type: none"> <li>• define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general</li> <li>• recognise and evaluate applied techniques and methods of their subject and are aware of their limits</li> <li>• identify, structure and solve problems/tasks, also in new or developing subject areas</li> <li>• apply state of the art and innovative methods to solve problems, if necessary from other disciplines</li> <li>• are aware of the current limits and contribute to the development of computer science research and technology</li> <li>• discuss and evaluate recent computer science developments</li> </ul> <p><b>Methodological competences</b> The students:</p> <ul style="list-style-type: none"> <li>• examine tasks with technical and research literature, write an academic article and present their solutions academically</li> <li>• evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</li> <li>• schedule time processes and resources</li> </ul> <p><b>Social competences</b> The students:</p> <ul style="list-style-type: none"> <li>• communicate with users and experts convincingly</li> </ul> <p><b>Self-competences</b> The students:</p> <ul style="list-style-type: none"> <li>• pursue the overall and special computer science development critically</li> <li>• develop and reflect self-developed hypotheses to theories independently</li> </ul>
<b>Module contents</b>	See assigned course description
<b>Reader's advisory</b>	As announced in course
<b>Links</b>	
<b>Language of instruction</b>	German
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	unregelmäßig
<b>Module capacity</b>	unlimited
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht

<b>Lern-/Lehrform / Type of program</b>	S oder V (2 SWS)	
<b>Vorkenntnisse / Previous knowledge</b>		
Examination	Time of examination	Type of examination
<b>Final exam of module</b>	At the end of the lecture period	Presentation or oral exam
<b>Course type</b>	Course or seminar	
<b>SWS</b>	2.00	
<b>Frequency</b>	WiSe	
<b>Workload attendance</b>	28 h	

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

<b>Module label</b>	Current Topics in 'Microrobotics and Control Engineering' II
<b>Module code</b>	inf369
<b>Credit points</b>	3.0 KP
<b>Workload</b>	90 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Die im Modul Lehrenden</li> <li>◦ Sergej Fatikow</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Die im Modul Lehrenden</li> <li>◦ Sergej Fatikow</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>This module integrates current developments in the field in adequate study courses.</p> <p><b>Professional competences</b> The students:</p> <ul style="list-style-type: none"> <li>• define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general</li> <li>• recognise and evaluate applied techniques and methods of their subject and are aware of their limits</li> <li>• identify, structure and solve problems/tasks, also in new or developing subject areas</li> <li>• apply state of the art and innovative methods to solve problems, if necessary from other disciplines</li> <li>• are aware of the current limits and contribute to the development of computer science research and technology</li> <li>• discuss and evaluate recent computer science developments</li> </ul> <p><b>Methodological competences</b> The students:</p> <ul style="list-style-type: none"> <li>• examine tasks with technical and research literature, write an academic article and present their solutions academically</li> <li>• evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</li> <li>• schedule time processes and resources</li> </ul> <p><b>Social competences</b> The students:</p> <ul style="list-style-type: none"> <li>• communicate with users and experts convincingly</li> </ul> <p><b>Self-competences</b> The students:</p> <ul style="list-style-type: none"> <li>• pursue the overall and special computer science development critically</li> <li>• develop and reflect self-developed hypotheses to theories independently</li> </ul>
<b>Module contents</b>	See assigned course description
<b>Reader's advisory</b>	As announced in course
<b>Links</b>	
<b>Language of instruction</b>	German
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	unregelmäßig
<b>Module capacity</b>	unlimited
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht

<b>Lern-/Lehrform / Type of program</b>	S oder V (2 SWS)	
<b>Vorkenntnisse / Previous knowledge</b>		
Examination	Time of examination	Type of examination
<b>Final exam of module</b>	At the end of the lecture period	Presentation or oral exam
<b>Course type</b>	Course or seminar	
<b>SWS</b>	2.00	
<b>Frequency</b>	SuSe or WiSe	
<b>Workload attendance</b>	28 h	

## inf374 - Special Topics in 'Automotive' I

<b>Module label</b>	Special Topics in 'Automotive' I
<b>Module code</b>	inf374
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Martin Georg Fränzle</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Martin Georg Fränzle</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>This module integrates current developments in the field in adequate study courses.</p> <p><b>Professional competences</b> The students:</p> <ul style="list-style-type: none"> <li>• define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general</li> <li>• recognise and evaluate applied techniques and methods of their subject and are aware of their limits</li> <li>• identify, structure and solve problems/tasks, also in new or developing subject areas</li> <li>• apply state of the art and innovative methods to solve problems, if necessary from other disciplines</li> <li>• are aware of the current limits and contribute to the development of computer science research and technology</li> <li>• discuss and evaluate recent computer science developments</li> </ul> <p><b>Methodological competences</b> The students:</p> <ul style="list-style-type: none"> <li>• evaluate and apply tools, technology and methods sophisticatedly</li> <li>• combine new and original approaches and methods creatively</li> <li>• evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</li> </ul> <p><b>Social competences</b> The students:</p> <ul style="list-style-type: none"> <li>• support team process by their abilities</li> </ul> <p><b>Self-competences</b> The students:</p> <ul style="list-style-type: none"> <li>• pursue the overall and special computer science development critically</li> <li>• implement innovative professional activities effectively and independently</li> </ul>
<b>Module contents</b>	See assigned course description, e.g. „Zielarchitekturen Eingebetteter Systeme für Automotive-Anwendungen“
<b>Reader's advisory</b>	As announced in course
<b>Links</b>	
<b>Language of instruction</b>	German
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	halbjährlich
<b>Module capacity</b>	unlimited
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht

**Lern-/Lehrform / Type of program** 2 Veranst. aus V, S, Ü, P, PR (4SWS)

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**Vorkenntnisse / Previous knowledge**

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Examination

Time of examination

Type of examination

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**Final exam of module**

Portfolio or presentation or oral exam

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**Course type**

VA-Auswahl

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**SWS**

2.00

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**Frequency**

SuSe or WiSe

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**Workload attendance**

28 h

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## inf375 - Special Topics in 'Automotive' II

<b>Module label</b>	Special Topics in 'Automotive' II
<b>Module code</b>	inf375
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>This module integrates current developments in the field in adequate study courses.</p> <p><b>Professional competences</b> The students:</p> <ul style="list-style-type: none"> <li>• define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general</li> <li>• recognise and evaluate applied techniques and methods of their subject and are aware of their limits</li> <li>• identify, structure and solve problems/tasks, also in new or developing subject areas</li> <li>• apply state of the art and innovative methods to solve problems, if necessary from other disciplines</li> <li>• are aware of the current limits and contribute to the development of computer science research and technology</li> <li>• discuss and evaluate recent computer science developments</li> </ul> <p><b>Methodological competences</b> The students:</p> <ul style="list-style-type: none"> <li>• evaluate and apply tools, technology and methods sophisticatedly</li> <li>• combine new and original approaches and methods creatively</li> <li>• evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</li> </ul> <p><b>Social competences</b> The students:</p> <ul style="list-style-type: none"> <li>• Support team process by their abilities</li> </ul> <p><b>**Self-competences**</b> The students:</p> <ul style="list-style-type: none"> <li>• pursue the overall and special computer science development critically</li> <li>• implement innovative professional activities effectively and independently</li> </ul>
<b>Module contents</b>	See assigned course description
<b>Reader's advisory</b>	As announced in course
<b>Links</b>	
<b>Language of instruction</b>	German
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	unregelmäßig
<b>Module capacity</b>	unlimited
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht
<b>Lern-/Lehrform / Type of program</b>	2 Verant. aus V, S, Ü, P, PR (4SWS)
<b>Vorkenntnisse / Previous knowledge</b>	

Examination	Time of examination	Type of examination
<b>Final exam of module</b>	The exam period will be announced during the course	Portfolio or presentation or oral exam
<b>Course type</b>	VA-Auswahl	
<b>SWS</b>	2.00	
<b>Frequency</b>	WiSe	
<b>Workload attendance</b>	28 h	

## inf376 - Current Topics in 'Automotive' I

<b>Module label</b>	Current Topics in 'Automotive' I
<b>Module code</b>	inf376
<b>Credit points</b>	3.0 KP
<b>Workload</b>	90 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>This module integrates current developments in the field in adequate study courses.</p> <p>Professional competences The students:</p> <ul style="list-style-type: none"> <li>• Define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general</li> <li>• Recognise and evaluate applied techniques and methods of their subject and are aware of their limits</li> <li>• Identify, structure and solve problems/tasks, also in new or developing subject areas</li> <li>• Apply state of the art and innovative methods to solve problems, if necessary from other disciplines</li> <li>• Are aware of the current limits and contribute to the development of computer science research and technology</li> <li>• Discuss and evaluate recent computer science developments</li> </ul> <p>Methodological competences The students:</p> <ul style="list-style-type: none"> <li>• Examine tasks with technical and research literature, write an academic article and present their solutions academically</li> <li>• Evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</li> <li>• Schedule time processes and resources</li> </ul> <p>Social competences The students:</p> <ul style="list-style-type: none"> <li>• Communicate with users and experts convincingly</li> </ul> <p>Self-competences The students:</p> <ul style="list-style-type: none"> <li>• Pursue the overall and special computer science development critically</li> <li>• Develop and reflect self-developed hypotheses to theories independently</li> </ul>
<b>Module contents</b>	See assigned course description
<b>Reader's advisory</b>	As announced in course
<b>Links</b>	
<b>Language of instruction</b>	German
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	unregelmäßig
<b>Module capacity</b>	unlimited
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht
<b>Lern-/Lehrform / Type of program</b>	S oder V (2 SWS)

**Vorkenntnisse / Previous knowledge**

Examination	Time of examination	Type of examination
<b>Final exam of module</b>	At the end of the lecture period	Presentation or oral exam
<b>Course type</b>	Course or seminar	
<b>SWS</b>	2.00	
<b>Frequency</b>	WiSe	
<b>Workload attendance</b>	28 h	

## inf377 - Current Topics in 'Automotive' II

<b>Module label</b>	Current Topics in 'Automotive' II
<b>Module code</b>	inf377
<b>Credit points</b>	3.0 KP
<b>Workload</b>	90 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Technische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>This module integrates current developments in the field in adequate study courses.</p> <p><b>Professional competences</b> The students:</p> <ul style="list-style-type: none"> <li>• define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general</li> <li>• recognise and evaluate applied techniques and methods of their subject and are aware of their limits</li> <li>• identify, structure and solve problems/tasks, also in new or developing subject areas</li> <li>• apply state of the art and innovative methods to solve problems, if necessary from other disciplines</li> <li>• are aware of the current limits and contribute to the development of computer science research and technology</li> <li>• discuss and evaluate recent computer science developments</li> </ul> <p><b>Methodological competences</b> The students:</p> <ul style="list-style-type: none"> <li>• examine tasks with technical and research literature, write an academic article and present their solutions academically</li> <li>• evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</li> <li>• schedule time processes and resources</li> </ul> <p><b>Social competences</b> The students:</p> <ul style="list-style-type: none"> <li>• communicate with users and experts convincingly</li> </ul> <p><b>Self-competences</b> The students:</p> <ul style="list-style-type: none"> <li>• pursue the overall and special computer science development critically</li> <li>• develop and reflect self-developed hypotheses to theories independently</li> </ul>
<b>Module contents</b>	See assigned course description
<b>Reader's advisory</b>	As announced in course
<b>Links</b>	
<b>Language of instruction</b>	German
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	unregelmäßig
<b>Module capacity</b>	unlimited
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht
<b>Lern-/Lehrform / Type of program</b>	S oder V (2 SWS)

**Vorkenntnisse / Previous knowledge**

Examination	Time of examination	Type of examination
<b>Final exam of module</b>	At the end of the lecture period	Presentation or oral exam
<b>Course type</b>	Course or seminar	
<b>SWS</b>	2.00	
<b>Frequency</b>	WiSe	
<b>Workload attendance</b>	28 h	

## inf450 - Correctness of Graph Programs

<b>Module label</b>	Correctness of Graph Programs
<b>Module code</b>	inf450
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Theoretische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Annegret Habel</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>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.</p> <p>Professional competence The students:</p> <ul style="list-style-type: none"> <li>• Describe the basics of graph programs and graph properties</li> <li>• Describe verification procedures of system correctness</li> </ul> <p>Methodological competence The students:</p> <ul style="list-style-type: none"> <li>• Model systems, system changes and system properties</li> <li>• Apply the formalism of graph programs</li> </ul> <p>Social competence The students:</p> <ul style="list-style-type: none"> <li>• Solve problems in a team</li> <li>• Present and discuss their proposed solutions</li> </ul> <p>Self-competence The students:</p> <ul style="list-style-type: none"> <li>• Reflect upon their actions with regard to term rewriting systems and the methods of those</li> </ul>
<b>Module contents</b>	<p>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.</p> <p>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.</p>
<b>Reader's advisory</b>	<ul style="list-style-type: none"> <li>• A. Habel, K.-H. Pennemann. Correctness of high-level transformation systems relative to nested conditions. <i>Mathematical Structures in Computer Science</i>, 19:245-296, 2009.</li> <li>• A. Habel, K.-H. Pennemann, A. Rensink. Weakest preconditions for high-level programs. In <i>Graph Transformations (ICGT 2006)</i>, LNCS 4178, 445-460, 2006.</li> <li>• K. Azab, A. Habel, K.-H. Pennemann, C. Zuckschwerdt. ENFORCe: A system for ensuring formal correctness of high-level programs. In <i>Electronic Communications of the EASST</i>, Vol. 1. 82-93, 2007.</li> </ul>
<b>Links</b>	

<b>Language of instruction</b>	German			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>	im 2-Jahres-Zyklus			
<b>Module capacity</b>	unlimited			
<b>Reference text</b>	Wird oft als Blockveranstaltung angeboten			
<b>Modullevel</b>	AC (Aufbaucurriculum / Composition)			
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht			
<b>Lern-/Lehrform / Type of program</b>				
<b>Vorkenntnisse / Previous knowledge</b>	- inf400 Theoretische Informatik I - inf401 Theoretische Informatik II			
<b>Examination</b>	Time of examination		Type of examination	
<b>Final exam of module</b>	Will be announced during the course		presentation or oral exam	
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Lecture		3.00	WiSe	42 h
Exercises		1.00	WiSe	14 h
<b>Total time of attendance for the module</b>				<b>56 h</b>

## inf453 - Combination of Specification Techniques

<b>Module label</b>	Combination of Specification Techniques
<b>Module code</b>	inf453
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Theoretische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Ernst-Rüdiger Olderog</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Andreas Hein</li> <li>◦ Ernst-Rüdiger Olderog</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	inf400/inf401 Theoretische Informatik I and II
<b>Skills to be acquired in this module</b>	<p>Introduction to the specification languages Z for data, CSP for processes, and their combination CSP-OZ for reactive systems with data and process parts.</p> <p><b>Professional competence</b> The students:</p> <ul style="list-style-type: none"> <li>• specify data and processes with Z, CSP and CSP-OZ formally</li> <li>• check data refinement relations formally</li> <li>• verify CSP-OZ specifications with FDR model checker</li> </ul> <p><b>Methodological competence</b> The students: - are able to integrate complementary specification methods</p> <p><b>Social competence</b> The students:</p> <ul style="list-style-type: none"> <li>• work together in small groups to solve problems</li> <li>• present solutions to problems to groups of other students</li> </ul> <p><b>Self-competence</b> The students:</p> <ul style="list-style-type: none"> <li>• learn persistence in pursuing difficult tasks</li> <li>• learn precision in specifying problems</li> </ul>
<b>Module contents</b>	<p>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.</p> <p>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.</p> <p><b>Topics:</b></p> <ul style="list-style-type: none"> <li>• specification of complex data and operations in Z, type definition and pattern calculations of Z, data refinement</li> <li>• specifications of communicating processes in CSP, operational semantics of CSP, three abstract semantic models</li> </ul> <p>for CSP: Trace semantics, failures semantics, failures-divergences semantics, process refinement in the above semantics, FDR model checker for CSP</p>

- 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**

<b>Language of instruction</b>	German			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>	unregelmäßig			
<b>Module capacity</b>	unlimited			
<b>Modullevel</b>	BC (Basiscurriculum / Base curriculum)			
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht			
<b>Lern-/Lehrform / Type of program</b>				
<b>Vorkenntnisse / Previous knowledge</b>	- inf400 Theoretische Informatik I - inf401 Theoretische Informatik II			
<b>Examination</b>	Time of examination		Type of examination	
<b>Final exam of module</b>	At the end of the lecture period		exercises and oral exam	
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Lecture		3.00	WiSe	42 h
Exercises		1.00	WiSe	14 h
<b>Total time of attendance for the module</b>				56 h

## inf454 - Communicating and Mobile Systems

<b>Module label</b>	Communicating and Mobile Systems
<b>Module code</b>	inf454
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Theoretische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Systems Engineering</li> </ul>

<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Ernst-Rüdiger Olderog</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Die im Modul Lehrenden</li> <li>◦ Ernst-Rüdiger Olderog</li> </ul>
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<b>Entry requirements</b>	
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<b>Skills to be acquired in this module</b>	Introduction to Milner's Calculus of Communicating Systems (CCS) and the $\lambda$ -Calculus.
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### Professional competence

The students:

- Know the theory of the operational semantics of CCS and the  $\lambda$ -calculus
- Perform equivalence proofs using simulations and bisimulations
- Specify communicating and mobile systems with CCS and the  $\lambda$ -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

<b>Module contents</b>	<p>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 <math>\lambda</math>-calculus. It enables a new modelling of communication, taking the location of the communication into account.</p> <p>The <math>\lambda</math>-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 <math>\lambda</math>-calculus, which is based on operational semantics and a concept of behavioural equivalence. The theory will be explained in a step-by-step manner.</p> <p><b>Topics:</b></p> <ul style="list-style-type: none"> <li>• different views on mobility</li> <li>• transition systems with simulations and bisimulations</li> <li>• Milner's Calculus of Communicating Systems (CCS) and Milner's <math>\lambda</math>-calculus for mobile systems, both with operational semantics, structural congruence, strong equivalence and observational equivalence, relationship between reactions and transitions, solvability of recursive equations</li> <li>• formal specification of examples of communicating and mobile systems using CCS and the <math>\lambda</math>-calculus</li> <li>• proof of strong equivalence and observational equivalence of given processes</li> </ul>
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- specification of dynamic data structures in the  $\pi$ -calculus

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**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.

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<b>Links</b>	<a href="http://csd.informatik.uni-oldenburg.de/">http://csd.informatik.uni-oldenburg.de/</a>			
<b>Languages of instruction</b>	German, English			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>	irregularly			
<b>Module capacity</b>	unlimited			
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)			
<b>Modulart</b>	Pflicht o. Wahlpflicht / compulsory or optional			
<b>Lern-/Lehrform / Type of program</b>	V+Ü			
<b>Vorkenntnisse / Previous knowledge</b>	Theoretische Informatik II			
<b>Examination</b>	Time of examination		Type of examination	
<b>Final exam of module</b>	At the end of the lecture period		written exam or oral exam	
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Lecture		3.00	SuSe	42 h
Exercises		1.00	SuSe	14 h
<b>Total time of attendance for the module</b>				<b>56 h</b>

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## inf456 - Real-Time Systems

<b>Module label</b>	Real-Time Systems
<b>Module code</b>	inf456
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Theoretische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Embedded Brain Computer Interaction</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Systems Engineering</li> </ul>

<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Ernst-Rüdiger Olderog</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Die im Modul Lehrenden</li> <li>◦ Ernst-Rüdiger Olderog</li> </ul>
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### Entry requirements

<b>Skills to be acquired in this module</b>	<p>Introduction to formal methods of the specification and verification of time sensitive systems and their combinations.</p> <p><b>Professional competence</b> The students:</p> <ul style="list-style-type: none"> <li>• Learn about different models of time and real-time properties</li> <li>• Specify and verify real-time systems</li> <li>• Model real-time systems using Timed Automata and PLC-Automata</li> <li>• Apply the model checker UPPAAL for the verification of real-time properties</li> <li>• Specify real-time systems using the Duration Calculus</li> <li>• Learn about decidability and undecidability results for real-time systems</li> </ul> <p><b>Methodological competence</b> The students:</p> <ul style="list-style-type: none"> <li>• Recognize logic and automata as adequate forms for describing real-time systems</li> </ul> <p><b>Social competence</b> The students:</p> <ul style="list-style-type: none"> <li>• Work together in small groups to solve problems</li> <li>• Present their solutions to groups of other students</li> </ul> <p><b>Self-competence</b> The students:</p> <ul style="list-style-type: none"> <li>• Learn persistence in pursuing difficult tasks</li> <li>• Learn precision in specifying problems</li> </ul>
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<b>Module contents</b>	<p>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.</p> <p>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 &amp; 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.</p> <p>Topics:</p>
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- 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

<b>Languages of instruction</b>	German, English			
<b>Duration (semesters)</b>	1 Semester			
<b>Module frequency</b>	irregularly			
<b>Module capacity</b>	unlimited			
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)			
<b>Modulart</b>	Pflicht o. Wahlpflicht / compulsory or optioal			
<b>Lern-/Lehrform / Type of program</b>	V+Ü			
<b>Vorkenntnisse / Previous knowledge</b>	Theoretische Informatik I + II			
<b>Examination</b>	Time of examination		Type of examination	
<b>Final exam of module</b>	At the end of the lecture period		Exercises and written or oral exam	
<b>Course type</b>	<b>Comment</b>	<b>SWS</b>	<b>Frequency</b>	<b>Workload attendance</b>
Lecture		3.00	SuSe or WiSe	42 h
Exercises		1.00	SuSe or WiSe	14 h
<b>Total time of attendance for the module</b>				<b>56 h</b>

## inf458 - Term Rewriting Systems

<b>Module label</b>	Term Rewriting Systems
<b>Module code</b>	inf458
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Theoretische Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Annegret Habel</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Annegret Habel</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>The objectives of this module are an introduction to (term) rewriting systems, termination and confluence, the undecidable sets of termination and confluence problems, verification procedures of termination and confluence</p> <p><b>Professional competence</b> The students:</p> <ul style="list-style-type: none"> <li>• describe the basics of term rewriting systems</li> <li>• characterise the undecidability of termination and confluence problems</li> <li>• describe verification procedures of termination and confluence</li> </ul> <p><b>Methodological competence</b> The students:</p> <ul style="list-style-type: none"> <li>• apply verification procedures of termination and confluence</li> <li>• apply Huet's completion procedure</li> </ul> <p><b>Social competence</b> The students:</p> <ul style="list-style-type: none"> <li>• solve problems in a team</li> <li>• present and discuss their results</li> </ul> <p><b>Self-competence</b> The students:</p> <ul style="list-style-type: none"> <li>• reflect their actions with regard to term rewriting systems and the methods of those</li> </ul>
<b>Module contents</b>	<p>The module is an introduction to term rewriting systems and provides verification procedures for termination and confluence.</p> <p>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.</p> <p>For this purpose reduction and simplification orders, critical pairs, orthogonality and Huet's completion procedure are introduced, examined and combined.</p>
<b>Reader's advisory</b>	<ul style="list-style-type: none"> <li>• Franz Baader, Tobias Nipkow: Term Rewriting and All That. Cambridge University Press, Cambridge 1998.</li> <li>• Terese: Term Rewriting Systems, Cambridge University Press, Cambridge, 2003.</li> </ul>
<b>Links</b>	
<b>Language of instruction</b>	German
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	im 2-Jahres-Zyklus
<b>Module capacity</b>	unlimited

<b>Reference text</b>	Blockveranstaltung			
<b>Modullevel</b>	AC (Aufbaucurriculum / Composition)			
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht			
<b>Lern-/Lehrform / Type of program</b>				
<b>Vorkenntnisse / Previous knowledge</b>				
Examination	Time of examination		Type of examination	
<b>Final exam of module</b>	At the end of the lecture period		exercises and oral or written exam	
Course type	Comment	SWS	Frequency	Workload attendance
Lecture		3.00	WiSe	42 h
Exercises		1.00	WiSe	14 h
<b>Total time of attendance for the module</b>				56 h

## inf513 - Energy Informatics Practical

<b>Module label</b>	Energy Informatics Practical
<b>Module code</b>	inf513
<b>Credit points</b>	6.0 KP
<b>Workload</b>	180 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Business Informatics (Master) &gt; Akzentsetzungsmodulare der Informatik</li> <li>• Master's Programme Computing Science (Master) &gt; Angewandte Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodulare</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Sebastian Lehnhoff</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	Programming with JAVA
<b>Skills to be acquired in this module</b>	<p>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.</p> <p>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.</p> <p><b>Professional competence</b> The students:</p> <ul style="list-style-type: none"> <li>• derive and evaluate computational models from physical models</li> <li>• use the "mosaik" smart grid co-simulation framework</li> <li>• analyze the requirements for successful applications to real power balancing regarding capacity utilization, robustness, and flexibility</li> <li>• name the foundations of planning and conducting simulation based experiments as well as the interpretation of the results</li> <li>• 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.</li> </ul> <p><b>Methodological competence</b> The students:</p> <ul style="list-style-type: none"> <li>• model simple controllable electrical generators and consumers</li> <li>• simulate simple controllable electrical generators and consumers with appropriate control algorithms within smart grid scenarios</li> <li>• apply distributed agent-based control schemes to decentralized energy generators and/ or consumers</li> <li>• evaluate simulation results</li> <li>• search information and look into methods to implement models</li> <li>• propose hypothesis and check their validity with design of experiments methods</li> </ul> <p><b>Social competence</b> The students:</p> <ul style="list-style-type: none"> <li>• apply the pair programming development technique</li> <li>• discuss design decisions</li> <li>• identify work packages and are responsible for it</li> </ul> <p><b>Self-competence</b> The students:</p> <ul style="list-style-type: none"> <li>• reflect on their own use of power as a limited resource</li> <li>• accept and use criticism to develop their own behaviour</li> </ul>

**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

<b>Links</b>	http://mosaik.offis.de	
<b>Language of instruction</b>	German	
<b>Duration (semesters)</b>	1 Semester	
<b>Module frequency</b>	jährlich	
<b>Module capacity</b>	unlimited	
<b>Reference text</b>	Elective module in the master specialization area (energy computer science).	
	Associated with the modules:	
	<ul style="list-style-type: none"> <li>• Energieinformationssysteme</li> <li>• Smart Grid Management</li> </ul>	
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)	
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht	
<b>Lern-/Lehrform / Type of program</b>		
<b>Vorkenntnisse / Previous knowledge</b>	<ul style="list-style-type: none"> <li>- Programmierung mit Java</li> <li>- Programmierung mit Python</li> </ul>	
<b>Examination</b>	Time of examination	Type of examination
<b>Final exam of module</b>	At the end of the semester	Oral exam
<b>Course type</b>	Practical	
<b>SWS</b>	4.00	
<b>Frequency</b>	SuSe	

**Workload attendance**

56 h

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## inf533 - Probabilistic Modelling I

<b>Module label</b>	Probabilistic Modelling I
<b>Module code</b>	inf533
<b>Credit points</b>	3.0 KP
<b>Workload</b>	90 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Business Informatics (Master) &gt; Akzentsetzungsmodule der Informatik</li> <li>• Master's Programme Computing Science (Master) &gt; Angewandte Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Embedded Brain Computer Interaction</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Systems Engineering</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Claus Möbus</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Claus Möbus</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>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.</p> <p><b>Professional competence</b> The students:</p> <ul style="list-style-type: none"> <li>• learn to map problem to model classes to come up with practical solutions</li> </ul> <p><b>Methodological competence</b> The students:</p> <ul style="list-style-type: none"> <li>• acquire basic skills in the design, implementation, and identification of probabilistic models with Bayesian methods</li> <li>• acquire knowledge about alternative non-Bayesian machine learning methods</li> </ul> <p><b>Social competence</b> The students:</p> <ul style="list-style-type: none"> <li>• learn to present and discuss probabilistic theories, methods, and models.</li> </ul> <p><b>Self-competence</b> The students:</p> <ul style="list-style-type: none"> <li>• reflect and evaluate chances and limitations of probabilistic approaches</li> <li>• learn to deliberate on machine-learning alternatives</li> </ul>
<b>Module contents</b>	Theories, methods, and examples of Bayesian models with practical applications
<b>Reader's advisory</b>	Recent eBooks, eTutorials
<b>Links</b>	<a href="http://www.uni-oldenburg.de/en/computingscience/lcs/probabilistic-programming/">http://www.uni-oldenburg.de/en/computingscience/lcs/probabilistic-programming/</a>
<b>Languages of instruction</b>	German, English
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	jährlich
<b>Module capacity</b>	unlimited
<b>Reference text</b>	<p>Associated with the module:</p> <ul style="list-style-type: none"> <li>• inf534 Probabilistic Modelling II</li> </ul>

<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)	
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht	
<b>Lern-/Lehrform / Type of program</b>	S	
<b>Vorkenntnisse / Previous knowledge</b>	Programmierkenntnisse	
<b>Examination</b>	Time of examination	Type of examination
<b>Final exam of module</b>	Will be announced in the lecture	Presentation, reflective summary
<b>Course type</b>	Seminar	
<b>SWS</b>	2.00	
<b>Frequency</b>	WiSe	
<b>Workload attendance</b>	28 h	

## inf534 - Probabilistic Modelling II

<b>Module label</b>	Probabilistic Modelling II
<b>Module code</b>	inf534
<b>Credit points</b>	3.0 KP
<b>Workload</b>	90 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Business Informatics (Master) &gt; Akzentsetzungsmodulare der Informatik</li> <li>• Master's Programme Computing Science (Master) &gt; Angewandte Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodulare</li> <li>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Embedded Brain Computer Interaction</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Claus Möbus</li> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Claus Möbus</li> <li>◦ Die im Modul Lehrenden</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>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.</p> <p><b>Professional competence:</b> The students:</p> <ul style="list-style-type: none"> <li>• learn to connect problem- with model classes to come up with practical solutions</li> </ul> <p><b>Methodological competence</b> The students:</p> <ul style="list-style-type: none"> <li>• acquire advanced skills in the design, implementation, and identification of probabilistic models with Bayesian methods</li> <li>• acquire knowledge about alternative machine learning methods</li> </ul> <p><b>Social competence</b> The students:</p> <ul style="list-style-type: none"> <li>• learn to present and discuss probabilistic theories, methods, and models</li> </ul> <p><b>Self-competence</b> The students:</p> <ul style="list-style-type: none"> <li>• reflect and evaluate chances and limitations of probabilistic approaches</li> <li>• learn to deliberate on machine-learning alternatives</li> </ul>
<b>Module contents</b>	Theories, methods, and examples of Bayesian models with practical applications
<b>Reader's advisory</b>	Recent publications
<b>Links</b>	<a href="http://www.uni-oldenburg.de/en/computingscience/lcs/probabilistic-programming/">http://www.uni-oldenburg.de/en/computingscience/lcs/probabilistic-programming/</a>
<b>Language of instruction</b>	German
<b>Duration (semesters)</b>	1 Semester
<b>Module frequency</b>	halbjährlich
<b>Module capacity</b>	unlimited
<b>Reference text</b>	<p><b>Associated with the module:</b></p> <ul style="list-style-type: none"> <li>• inf533 Probabilistische Modellierung I</li> </ul>

<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)	
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht	
<b>Lern-/Lehrform / Type of program</b>		
<b>Vorkenntnisse / Previous knowledge</b>	- Grundkenntnisse Progeammierung	
<b>Examination</b>	Time of examination	Type of examination
<b>Final exam of module</b>	individuell in Absprache mit dem Lehrenden	seminar talk, reflective written summary
<b>Course type</b>	Seminar	
<b>SWS</b>	2.00	
<b>Frequency</b>	SuSe	
<b>Workload attendance</b>	28 h	

## inf950 - Interdisciplinary Module I

<b>Module label</b>	Interdisciplinary Module I	
<b>Module code</b>	inf950	
<b>Credit points</b>	6.0 KP	
<b>Workload</b>	180 h	
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Nicht Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>	
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Die im Modul Lehrenden</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Die im Modul Lehrenden</li> </ul>	
<b>Entry requirements</b>		
<b>Skills to be acquired in this module</b>	<p><b>Ziele des Moduls/Kompetenzen:</b> Die Absolventinnen und Absolventen kennen die Grundlagen und anwendungsrelevanten Hintergründe der ausgewählten Disziplin.</p> <p><b>Fachkompetenzen</b> Die Studierenden:</p> <ul style="list-style-type: none"> <li>• benennen die Grundlagen und Methoden des gewählten Gebietes</li> <li>• wenden die Fachsprache des Anwendungsgebietes kompetent an</li> </ul> <p><b>Methodenkompetenzen</b> Die Studierenden:</p> <ul style="list-style-type: none"> <li>• charakterisieren Nutzungskontext und Anforderungen von IT im gewählten Gebiet</li> <li>• wenden die disziplinären Methoden und Techniken des Anwendungsgebietes an und kontrastieren diese mit den aus der Informatik bekannten Methoden und Techniken</li> <li>• untersuchen Probleme eines Anwendungsgebietes mit den disziplin-typischen Methoden</li> </ul> <p><b>Sozialkompetenzen</b> Die Studierenden:</p> <ul style="list-style-type: none"> <li>• können die Verschiedenheit von Fachkulturen einschätzen und respektieren andere Fachgebiete und deren Arbeitsweise</li> <li>• bereiten sich auf Anwendungsszenarien für IT-Systeme vor</li> </ul> <p><b>Selbstkompetenzen</b> Die Studierenden:</p> <ul style="list-style-type: none"> <li>• reflektieren ihr Selbstbild und Handeln vor dem Hintergrund einer anderen Fachdisziplin</li> </ul>	
<b>Module contents</b>	<p>Das Modul wird mit Fachmodulen aus anderen Disziplinen oder Modulen des Departments für Informatik instanziiert, die als Nicht Informatik-Modul gekennzeichnet sind.</p> <p>Die Veranstaltungsformen und Prüfungsmodalitäten orientieren sich an dem jeweils gewählten Modul.</p>	
<b>Reader's advisory</b>		
<b>Links</b>		
<b>Languages of instruction</b>		
<b>Duration (semesters)</b>	1 Semester	
<b>Module frequency</b>		
<b>Module capacity</b>	unlimited	
<b>Modullevel</b>	AS (Akzentsetzung / Accentuation)	
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht	
<b>Lern-/Lehrform / Type of program</b>		
<b>Vorkenntnisse / Previous knowledge</b>		
<b>Examination</b>	Time of examination	Type of examination
<b>Final exam of module</b>	M	

**Course type** VA-Auswahl

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**SWS** 2.00

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**Frequency** WiSe

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**Workload attendance** 28 h

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## inf951 - Interdisciplinary Module II

<b>Module label</b>	Interdisciplinary Module II	
<b>Module code</b>	inf951	
<b>Credit points</b>	6.0 KP	
<b>Workload</b>	180 h	
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Computing Science (Master) &gt; Nicht Informatik</li> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</li> </ul>	
<b>Contact person</b>		
<b>Entry requirements</b>		
<b>Skills to be acquired in this module</b>		
<b>Module contents</b>		
<b>Reader's advisory</b>		
<b>Links</b>		
<b>Languages of instruction</b>		
<b>Duration (semesters)</b>	1 Semester	
<b>Module frequency</b>		
<b>Module capacity</b>	unlimited	
<b>Modullevel</b>	BC (Basiscurriculum / Base curriculum)	
<b>Modulart</b>	je nach Studiengang Pflicht oder Wahlpflicht	
<b>Lern-/Lehrform / Type of program</b>		
<b>Vorkenntnisse / Previous knowledge</b>		
<b>Examination</b>	Time of examination	Type of examination
<b>Final exam of module</b>		M
<b>Course type</b>	VA-Auswahl	
<b>SWS</b>	2.00	
<b>Frequency</b>	WiSe	
<b>Workload attendance</b>	28 h	

# Abschlussmodul

## mam - Master's Thesis Module

<b>Module label</b>	Master's Thesis Module
<b>Module code</b>	mam
<b>Credit points</b>	30.0 KP
<b>Workload</b>	900 h
<b>Used in course of study</b>	<ul style="list-style-type: none"> <li>• Master's Programme Embedded Systems and Microrobotics (Master) &gt; Abschlussmodul</li> </ul>
<b>Contact person</b>	<p>Module responsibility</p> <ul style="list-style-type: none"> <li>◦ Michael Sonnenschein</li> <li>◦ Lehrende der Informatik</li> </ul> <p>Authorized examiners</p> <ul style="list-style-type: none"> <li>◦ Lehrende der Informatik</li> </ul>
<b>Entry requirements</b>	
<b>Skills to be acquired in this module</b>	<p>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.</p> <p>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.</p> <p>The master's thesis is finished by a colloquium.</p> <p>Professional competence The students:</p> <ul style="list-style-type: none"> <li>• Recognise and evaluate applied techniques and methods of their subject and are aware of their limits</li> <li>• 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</li> <li>• Identify, structure and solve problems/tasks, also in new or developing subject areas</li> <li>• Apply state of the art and innovative methods to solve problems, if necessary from other disciplines</li> <li>• Relate knowledge from different disciplines and apply this new knowledge in complex situations</li> <li>• Develop complex computer systems, processes and datamodels</li> <li>• Are aware of the current limits and contribute to the development of computer science research and technology</li> <li>• Discuss and evaluate recent computer science developments</li> </ul> <p>Methodological competence The students:</p> <ul style="list-style-type: none"> <li>• Identify and develop one or more solutions</li> <li>• Evaluate and apply tools, technology and methods sophisticatedly</li> <li>• Examine tasks with technical and research literature, write an academic article and present their solutions academically</li> <li>• Schedule processes and resources</li> <li>• Apply project management techniques</li> <li>• Combine new and original approaches and methods creatively</li> <li>• Evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</li> </ul> <p>Social competence The students:</p> <ul style="list-style-type: none"> <li>• Communicate with users and experts convincingly</li> <li>• Take reasonable decisions</li> </ul> <p>Self-competence The students:</p> <ul style="list-style-type: none"> <li>• Pursue the overall and special computer science development critically</li> <li>• Implement innovative professional activities effectively and independently</li> <li>• Recognise their abilities and extend them purposefully</li> </ul>

- 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

<b>Module contents</b>	The content of this module is an independent topic research. The research findings will be presented and discussed in a master's thesis colloquium.	
<b>Reader's advisory</b>	Wird entsprechend des konkreten Themas spezifiziert.	
<b>Links</b>	<a href="https://www.uni-oldenburg.de/informatik/studium-lehre/infos-zum-studium/abschlussarbeiten/">https://www.uni-oldenburg.de/informatik/studium-lehre/infos-zum-studium/abschlussarbeiten/</a>	
<b>Languages of instruction</b>	German, English	
<b>Duration (semesters)</b>	1 Semester	
<b>Module frequency</b>	halbjährlich	
<b>Module capacity</b>	unlimited	
<b>Modullevel</b>	Abschlussmodul (Abschlussmodul)	
<b>Modulart</b>	Pflicht	
<b>Lern-/Lehrform / Type of program</b>	Anfertigen einer Masterarbeit	
<b>Vorkenntnisse / Previous knowledge</b>		
Examination	Time of examination	Type of examination
<b>Final exam of module</b>	individuell	Master's thesis, presentation and discussion.
<b>Course type</b>	Seminar	
<b>SWS</b>	0.00	
<b>Frequency</b>	SuSe and WiSe	
<b>Workload attendance</b>	0 h	

