Modulhandbuch

Embedded Systems and Microrobotics - Master's Programme

im Sommersemester 2021

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Kernmodule
inf900 - Group Project

Module label | Group Project
Module abbreviation | inf900
Credit points | 24.0 KP
Workload | 720 h

Applicability of the module
- Master's Programme Business Informatics (Master) > Kernmodule
- Master's Programme Computing Science (Master) > Kernmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Responsible persons
- Peter, Andreas (module responsibility)
- Marx Gómez, Jorge (module responsibility)
- Boll-Westermann, Susanne (module responsibility)
- Lehrenden, Die im Modul (authorised to take exams)

Prerequisites
- Programming course
- Software Engineering
- Soft Skills

Skills to be acquired in this module
The students get familiar with different software development aspects in a team. Apart from software engineering knowledge and skills they develop key competences like project management, teamwork, problem solving competence and conflict management. Additionally, students develop special knowledge, skills and competences from the project group topic.

Professional competence
The students:
- characterise and apply computer science basics (algorithms, data structures, programming, basics of practical, technical and theoretcal computer science)
- define und describe essential mathematical, logical and physical basics of computer science
- define and illustrate the core disciplines of computer science (theoretical, practical and technical computer science)

Methodological competence
The students:
- examine problems, use formal methods to phrase and analyze them appropriately
- evaluate problems by the use of technical and scientific literature
- reflect on a scientific topic and write a scientific seminar paper under guidance and present their findings

Social competence
The students:
- integrate criticism into their own actions
- respect team decisions
- communicate with users and experts convincingly

Self-competence
The students:
- take on project management tasks
- pursue the overall and special computer science development critically
- implement innovative professional activities effectively and independently
- recognise their abilities and extend them purposefully
- reflect their self-perception and actions with regard to professional, methodological and social aspects
- develop and reflect self-developed hypotheses to theories independently
- work in their field independently

Module contents
Cooperative development of a large-scale computer science project. This project general includes the (further) development of a hard or software system.
<table>
<thead>
<tr>
<th><strong>Recommended reading</strong></th>
<th>According to the assigned task</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Links</strong></td>
<td><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></td>
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<tr>
<td><strong>Languages of instruction</strong></td>
<td>German, English</td>
</tr>
<tr>
<td><strong>Duration (semesters)</strong></td>
<td>2 Semester</td>
</tr>
<tr>
<td><strong>Module frequency</strong></td>
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<td><strong>Module capacity</strong></td>
<td>unlimited</td>
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<tr>
<td><strong>Reference text</strong></td>
<td>Dieses Modul ist im Rahmen der Projekte FiFi und FoL konzipiert worden</td>
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<tr>
<td><strong>Module level</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Type of module</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Teaching/Learning method</strong></td>
<td>PG</td>
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</table>
| **Previous knowledge**  | - Programming course  
- Software Engineering  
- Soft Skills |
| **Examination**         | |
| **Examination times**   | At the End of the semester term |
| **Type of examination** | Active involvement, presentation, final report, project assessment |
| **Type of course**      | Project group |
| **SWS**                 | 8 |
| **Frequency**           | SoSe und WiSe |
| **On-site workload**    | 112 h |
## Akzentsetzungsmodule

### inf100 - Human Computer Interaction

<table>
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<tr>
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<th>Human Computer Interaction</th>
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<tr>
<td>Module abbreviation</td>
<td>inf100</td>
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<tr>
<td>Credit points</td>
<td>6.0 KP</td>
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<tr>
<td>Workload</td>
<td>180 h</td>
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### Applicability of the module
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Praktische Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction

### Responsible persons
- Boll-Westermann, Susanne (module responsibility)
- Lehrenden, Die im Modul (authorised to take exams)

### Prerequisites
Useful previous knowledge: Interactive Systems

### Skills to be acquired in this module

#### Professional competence
The students:
- can describe and explain the HCD process.
- can classify an unknown method into the HCD process when they are presented with a brief description.
- can select a suitable prototyping approach for a given application.
- can select a suitable prototyping method for a given application.
- can apply selected prototyping methods to create an interactive system.
- can name basic characteristics of human perception and motor skills and explain their importance for the development of interactive systems.
- can suggest and motivate improvement for a given user interface based on the gestalt laws.
- can explain the characteristics of human visual search and utilize it to improve given interfaces.
- can critically compare several variants of an interactive system's concept based on the "Multiple Resource Theory".

#### Methoden competence
The students:
- can critically compare and select methods for context of use and/or user requirements analysis.
- can apply methods for context of use and/or user requirements analysis to a real-world example.
- can retrospectively discuss and evaluate the use of a method for context of use and/or user requirements analysis.
- can plan, moderate and evaluate an ideation session.
- can formulate a precise research question based on a given problem description.
- can discuss the advantages and disadvantages of an experiment design.
- can select a suitable experiment design for a given research question.
- can define hypotheses and null hypotheses for a given experiment.

#### Social competence
The students:
- can work out solutions for a given design problem in group work.
- can present solutions to design problem in the plenum.
- can motivate their methodical approach to a design problem.
- can discuss their designs and results in an appropriate and professional manner with the plenum.
- can accept criticisms by their peer group as valuable contributions to their designs.

#### Self-competence:
The students:

- can accept and learn from mistakes made during the design process.

**Module contents**

The module covers research methods in the field of human-computer interaction. It discusses the core principles of human-computer interaction and the human-centered design process and its phases, context of use, requirements, and task analysis, prototyping and evaluation. Research methods used in the different phases of the process are introduced and discussed.

Available design options for human-machine interfaces are presented and discussed with regard to human perception capabilities and their limitations. The module discusses methods for user research, including surveys, diaries, case studies, interviews, and focus groups, as well as physiological measurements. The module goes into further detail on evaluation methods, and introduces the foundations of experimental research in human-computer interaction, including types of research, research hypotheses, experimental design, and statistical analysis.

During the practical project, a concrete human-computer interface will be designed, developed and evaluated.

**Recommended reading**

- Literature in the reserve shelf in the university bibliography.
- Link list in Stud.IP.

**Links**

https://uol.de/en/media-informatics/teaching/courses

**Languages of instruction**

German, English

**Duration (semesters)**

1 Semester

**Module frequency**

every summer term

**Module capacity**

unlimited

**Reference text**

**Type of module**

**Teaching/Learning method**

1VL + 1Ü

**Previous knowledge**

Useful previous knowledge: Interactive Systems

**Examination**

Examination times

Type of examination

**Final exam of module**

The completed practical projects will be presented on a single project day, which will take place at the end of the lecture period. The oral exam takes place within the last two weeks of the lecture period. If necessary, re-examinations will take place at the end of the term. Details on the schedule can be found on the websites of the department and in Stud.IP.

**Portfolio**

**Type of course**

<table>
<thead>
<tr>
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<th>SWS</th>
<th>Frequency</th>
<th>Workload of compulsory attendance</th>
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<tbody>
<tr>
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<td>SoSe</td>
<td>28</td>
</tr>
<tr>
<td>Exercises</td>
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<td>SoSe</td>
<td>28</td>
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</table>

**Total module attendance time**

56 h
inf105 - Fault Tolerance in Distributed Systems

### Module label
Fault Tolerance in Distributed Systems

### Module abbreviation
inf105

### Credit points
6.0 KP

### Workload
180 h

### Applicability of the module
- Master's Programme Computing Science (Master) > Praktische Informatik

### Responsible persons
- Theel, Oliver (module responsibility)
- Lehrenden, Die im Modul (authorised to take exams)

### Prerequisites
useful previous knowledge: Distributed operating systems

### Skills to be acquired in this module
This module provides knowledge of fault-tolerant distributed systems. The terminology, structure, conception, core challenges and related implementation concepts will be covered in detail.

#### Professional competence
The students:
- assess what a fault-tolerant distributed system is and develop awareness of its capabilities
- name and discuss common implementations of fault-tolerant distributed systems

#### Methodological competence
The students:
- reflect the implementation challenges of a distributed system
- are able to adapt and evolve implementation concepts of fault-tolerant distributed systems in new contexts

#### Social competence
The students:
- solve problems in small teams
- present their solutions to the members of the tutorial
- discuss their different solutions with members of the tutorial

#### Self-competence
The students:
- accept criticism
- question their initially applied methods for problem solving
- question their initial solutions in the light of newly learned methods

### Module contents

1. Fault, Error, Failure
2. Failure semantics, Fault tolerance
3. Byzantine agreement protocols
4. Stable storage
5. Fail-stop processors
6. Atomic commit protocols
7. Classification of replication control schemes - pessimistic vs. optimistic - semantic vs. syntactic - static vs. dynamic
8. Consistency notions
9. Quality criteria
10. Survey of replication control schemes
11. Design of replication control schemes
12. Unifying frameworks
13. Replication in practice

### Recommended reading
### Links

<table>
<thead>
<tr>
<th>Language of instruction</th>
<th>German</th>
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<tr>
<td>Reference text</td>
<td>connectet with: Betriebssysteme 1 und 2 Betriebssysteme-Praktikum Verteilte Betriebssysteme</td>
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### Module level

#### Type of module

<table>
<thead>
<tr>
<th>Teaching/Learning method</th>
<th>1VL + 1S or 1VL + 1Ü</th>
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#### Previous knowledge

| Distributed operating systems |

#### Examination

<table>
<thead>
<tr>
<th>Examination times</th>
<th>Type of examination</th>
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#### Final exam of module

<table>
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<tr>
<th>End of lecture period</th>
<th>Written exam or oral exam or practical work</th>
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#### Type of course

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<th>Comment</th>
<th>SWS</th>
<th>Frequency</th>
<th>Workload of compulsory attendance</th>
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<td>WiSe</td>
<td>28</td>
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<tr>
<td>Seminar or exercise</td>
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<td>2</td>
<td>WiSe</td>
<td>28</td>
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#### Total module attendance time

| 56 h |
inf300 - Hybrid Systems

Module label: Hybrid Systems
Module abbreviation: inf300
Credit points: 6.0 KP
Workload: 180 h

Applicability of the module:
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Computing Science (Master) > Theoretische Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Responsible persons:
- Fränzle, Martin Georg (module responsibility)
- Lehrenden, Die im Modul (authorised to take exams)

Prerequisites:
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.

Skills to be acquired in this module:
The students:
- characterise formal models of cyber-physical systems: hybrid automata, hybrid state transition systems
- name domain-specific system requirements: safety, stability, robustness
- name analysis methods: symbolic state-space exploration, abstraction and abstraction refinement, generalized Lyapunov-Methods
- use state-of-the-art analysis tools
- select and apply adequate modelling and analysis methods for concrete application scenarios
- apply methods to reduce large state spaces and reduce infinite-state systems by abstraction
- know the de-facto industry standards for system modelling and are able to apply the corresponding modelling frameworks and tools

Professional competence:
The students:
- model heterogeneous dynamical systems with adequate modelling and design tools, in particular Simulink/Stateflow
- transfer modelling and analysis methods to other heterogeneous domains, e.g. socio-technical systems

Social competence:
The students:
- work in teams
- solve complex modelling, design, and analysis tasks in teams

Self-competence:
The students:
- reflect their actions and respect the scope of methods dedicated to hybrid systems

Module contents:
Embedded computer systems continuously interact with their environment, which generally comprises state- and time-continuous components. The coupling of the embedded system to its environment thus induces complex interweavings between discrete computational and decision processes and continuous processes. The resulting processes are neither amenable to the analytic techniques of continuous control nor of discrete mathematics. They instead require a broader, integrated theory: hybrid discrete-continuous systems. The lectures provide an in-depth introduction into a variety of analysis and design methods of these computer-based systems and their recent extensions to cyber-physical systems. The accompanying hands-on-project enhances the lecture by developing and using design and verification tools.

Recommended reading:

### Links

<table>
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<tr>
<th>Languages of instruction</th>
<th>English, German</th>
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<tr>
<td>Duration (semesters)</td>
<td>1 Semester</td>
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<td>Module frequency</td>
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<td>1V+ 1Ü</td>
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<tr>
<td>Previous knowledge</td>
<td>Bachelor in Computing Science or knowledge of ordinary differential equations</td>
</tr>
<tr>
<td>Examination</td>
<td>Examination times Type of examination</td>
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<tr>
<td>Final exam of module</td>
<td>At the end of the lecture period Semester project including written work and final presentation</td>
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<tr>
<td>Type of course</td>
<td>Comment SWS Frequency Workload of compulsory attendance</td>
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<td>Exercises</td>
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<td>Total module attendance time</td>
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**inf301 - Machine-oriented Systems Engineering**

<table>
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<tbody>
<tr>
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<tr>
<td>Credit points</td>
<td>6.0 KP</td>
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<td>Workload</td>
<td>180 h</td>
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</table>
| Applicability of the module | • Master's Programme Computing Science (Master) > Technische Informatik  
                               • Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction  
                               • Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction  
                               • Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering |
| Responsible persons   | • Fränzle, Martin Georg (module responsibility)  
                               • Lehrenden, Die im Modul (authorised to take exams) |
| Prerequisites         | No participant requirements            |
| Skills to be acquired in this module | The module provides practical relevance to the design of digital embedded systems.  
                                        **Professional competence**  
                                        The students:  
                                        • characterise the structure of microprocessor systems  
                                        • name control aspects of time sensitive external components  
                                        • program efficient embedded systems  
                                        **Methodological competence**  
                                        The students:  
                                        • use specifications from electrical components data sheets  
                                        **Social competence**  
                                        The students:  
                                        • work in a team  
                                        • discuss solutions |
<p>| Module contents       | Embedded systems support complex feedback problems, control problems and data processing tasks. They have an important value creation potential for telecommunications, production management, transport and electronics. The functionality of embedded systems is realised by the integration of processors, special hardware and software. The embedded systems design is influenced by the heterogeneity of system architectures, the complexity of systems and technical and economic requirements. This module gives an initial review of computer architectures. After that embedded systems are introduced by a specific microprocessor. Furthermore, external hardware will be connected to the microprocessor. Besides this, the design of circuit boards will be discussed. The students will design, develop and implement a circuit layout with CAD and programme this embedded system with a Flash-eprom. |
| Recommended reading   | Lecturers notes, hardware manuals and data sheets, and development tool manuals |
| Links                 |                                      |
| Languages of instruction | German, English                      |
| Duration (semesters)  | 1 Semester                           |
| Module frequency      | annual                                |
| Module capacity       | unlimited                             |
| Module level          |                                      |
| Type of module        |                                      |
| Teaching/Learning method | 1VL + 1P                           |
| Previous knowledge    | none                                  |
| Examination           | Examination times                     |
| Final exam of module  | At the end of the lecture period      | Portfolio (Design, development and implementation of embedded systems, colloquium) |</p>
<table>
<thead>
<tr>
<th>Type of course</th>
<th>Comment</th>
<th>SWS</th>
<th>Frequency</th>
<th>Workload of compulsory attendance</th>
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<td>Practical training</td>
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<td></td>
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inf303 - Fuzzy Control and Artificial Neural Networks in Robotics and Automation

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<tbody>
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<td>Module abbreviation</td>
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<tr>
<td>Credit points</td>
<td>6.0 KP</td>
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<tr>
<td>Workload</td>
<td>180 h</td>
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**Applicability of the module**

- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

**Responsible persons**

- Fatikow, Sergej (module responsibility)
- Lehrenden, Die im Modul (authorised to take exams)

**Prerequisites**

No participant requirements

**Skills to be acquired in this module**

Experts in different branches try to approach their application-specific control and information processing problems by using fuzzy logic and artificial neural networks (ANN). The experiences gathered up to now prove robotics and automation technology to be predestined fields of application of both these approaches. The major topics of the course are control problems in robotics and automation technology, principles of fuzzy logic and ANN and their practical 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.

**Professional competence**

The students:

- recognise control problems in robotics and automation technology,
- name principles of fuzzy logic and ANN and their practical applications,
- compare conventional and advanced control methods, characterise the combination of fuzzy logic and ANN in control systems

**Methodological competence**

The students:

- will acquire knowledge of the tools, methods and applications in fuzzy logic and ANN
- deepen their knowledge for the practical use of the given methods
- can use common software tools for design and application of fuzzy logic and ANN

**Social competence**

The students:

- gain experience in interdisciplinary work
- are integrated into the recent research work Objective of the module / skills:

**Self-competence**

The students:

- are able to transfer the gained knowledge for later use in their theses or studies for AMiR
- can Design (complex) fuzzy logic controller and ANN systems
- reflect their (control) solutions by using methods learned in this course

**Module contents**

- Control problems in robotics and automation technology
- Basic ideas of fuzzy logic and ANN
- Principles of fuzzy logic
- Fuzzy logic of rule-based systems
- ANN models
- ANN learning rules
- Multilayer perceptron networks and backpropagation
• Associative networks
• Self-organizing feature maps
• PID design principles
• Design of fuzzy control systems
• Fuzzy logic application examples
• Design of ANN control systems
• ANN application examples
• Fuzzy + Neuro: principles and applications

Recommended reading

Essentiell:

• Vorlesungsskript in Buchform (erhältlich im Sekretariat, A1-3-303)

Empfohlen:

• Kahler, J.: Fuzzy Control für Ingenieure, Vieweg, Braunschweig Wiesbaden, 1995

Gute Sekundärliteratur:

• Altrock, M. O. R.: Fuzzy Logic, R. Oldenbourg Verlag, 1993
• Kahler, J. und Hubert, F.: Fuzzy-Logik und Fuzzy-Control, Vieweg, 1993
• Kratzel, K.P.: Neuronale Netze, Carl Hanser, 1993
• Lawrence, J.: Neuronale Netze, Syntagma 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. and Liu, X.: Neural Networks for Identification, Prediction and Control, Springer, 1997
• Rigoll, G.: Neuronale Netze, Expert Verlag, Renningen-Malsheim, 1994
• Zakarian, S. Ladewig-Riebler, P. und Thoer, St.: Neuronale Netze für Ingenieure, Vieweg, Wiesbaden, 1998
• Zimmermann H.-J. (Hrsg.): Datenanalyse, VDI-Verlag, 1995
• Zimmermann, H.-J. (Hrsg.): Neuro + Fuzzy: Technologien und Anwendungen, VDI-Verlag, 1995

Languages of instruction

English, German

Duration (semesters)

1 Semester

Module frequency

annual

Module capacity

unlimited

Module level

Type of module

Links
<table>
<thead>
<tr>
<th>Teaching/Learning method</th>
<th>1VL + 1Ü</th>
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</table>
### Module Contents

Medical areas and areas of application
- Basic requirements for medical systems (hygiene, MPG, technical security, materials)

Medical systems:
- Functional diagnostics (ECG, EMG, EEG)
- Imaging systems (CT, MRI, ultrasound, PET, SPECT)
- Therapy equipment (Laser, RF, Microtherapy)
- Signal processing / monitoring (cardiovascular, hemodynamic, respiratory, metabolic, cerebral)
- Medical Informatics (HIS, DICOM, Telemedicine, VR, image processing)

### Resources

#### Essential:
- Kramme, R.: Medizintechnik. Verfahren, Systeme und
Informationssysteme, Springer Verlag, 2002 (2. Auflage)
- Lecture slides
- recommended:

secondary literature:

Links

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Total module attendance time 56 h
inf307 - Robotics

Module label
Robotics

Module abbreviation
inf307

Credit points
6.0 KP

Workload
180 h

Applicability of the module
- Master's Programme Computing Science (Master) > Interdisziplinäre Module
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Responsible persons
- Hein, Andreas (module responsibility)
- Lehrenden, Die im Modul (authorised to take exams)

Prerequisites
No participant requirements

Skills to be acquired in this module
Professional competence
The students:
- Name and know the functions and applications of robot systems
- Characterise the basic concepts to program robot systems
- Differentiate between the interaction of mechanical, electrical and software components

Methodological competence
The students:
- Define characteristics and components of robot systems for a specific application
- Design and implement robot system sub-components
- Design and parameterise simple control structures
- Plan the application of robot systems and derive the requirements
- Model electrical and mechanical systems
- Develop and realise simple robot systems

Social competence
The students:
- Solve robot systems problems in team work

Self-competence
The students:
- Reflect their solutions in reference to robot system methods

Module contents
Integration in production plants / aims / subsystems
- Architectures / classifications (classification of robots)
- Robot components + Computer systems for programming -- PA-10 -- Lego Mindstorms
- Basics of kinematics -- Coordinate transformation, homogeneous coordinates, Coordinate transitions -- Kinematic equation systems, transformation of vectors
- Kinematic -- Joint types (manipulators) / Wheels, TCP -- Denavit-Hartenberg-Transformation -- Forward calculation -- Backward calculation
- Sensors -- General properties of sensors, parameter -- Simple optical position sensors -- Inductive-, capacitive- und ultrasonic-sensors -- Distance sensors (laser scanner, triangulation sensors) -- Force sensors -- Sensor data preparation
- Planing / Regulation -- Overall regulation approach, terms, process- and control functions, PID-controller -- Planning concepts and approaches (On-Line, Off-Line), planning processes, construction and path planning - Actuators

Recommended reading

essential:
- lecture nodes

**recommended:**


**secondary literature:**


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**Links**

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**Type of course**

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**Total module attendance time**

56 h
# inf308 - Microrobotics II

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## Applicability of the module
- Master's Programme Computing Science (Master) > Interdisziplinäre Module
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

## Responsible persons
- Fatikow, Sergej (module responsibility)
- Lehrenden, Die im Modul (authorised to take exams)

## Prerequisites
- Microrobotics and Microsystems Engineering

## Skills to be acquired in this module

**After having given an established introduction in the module “Microrobotics and Microsystem Technology” this lecture offers a further specialisation in microrobotics. Within the course, all relevant areas (among others the research topics of the division “Microrobotics and Control Engineering (AMiR)”) will be presented and analysed. The student will be provided with an insight into current research projects of AMiR and of other research institutes of microrobotics worldwide; here mainly the requirements of industry to microrobots will be discussed. The lecture will be enhanced by practical courses in the research laboratories of AMiR.**

### Professional competence
The students:

- name and recognise the basic concepts of nanotechnology, in particular, micro- and nanorobotics approaches
- differentiate the development, control and application of micro- and nanorobotics systems - implement and design application-specific micro- and nanorobotics systems

### Methodological competence
The students:

- transfer their control engineering and image processing abilities on interdisciplinary problems
- transfer their hands-on experience to develop controls and applications of microrobotic systems on new tasks

### Social competence
The students:

- work in a team

### Self-competence
The students:

- reflect their problem-solving behaviour and use hands-on experience to develop, control and application of microrobotics

## Module contents

- Smart and versatile microrobots; microactuators (piezo-, ferrofluid- and SMA-actuators) for microrobots;
- real-time image processing in the micro world (SEM, optical microscopy);
- micro force sensors and tactile sensors for microrobots;
- microrobot control systems, e.g. neural networks and fuzzy logic;
- haptic interface for the control of microrobots;
- neural speech interface for the control of microrobots;
- robot-based micro- and nanohandling (SEM, optical microscopy);
- applications: microassembly, nano-testing, cell handling;
- Micro Air Vehicles (MAVs); multi-robot systems: team behavior, communication, control issues
Recommended reading

- Lecture notes (can be obtained in secretariate, A1-3-303)

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Total module attendance time 56 h
inf311 - Low Energy System Design

Module label | Low Energy System Design
Module abbreviation | inf311
Credit points | 6.0 KP
Workload | 180 h

Applicability of the module
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Responsible persons
- Fatikow, Sergej (module responsibility)
- Lehrenden, Die im Modul (authorised to take exams)

Prerequisites

Skills to be acquired in this module

Professional competence
The students:
- Discuss the fundamental problems of power dissipation
- Characterise the requirements-driven design process of embedded systems
- Name power loss analysis and optimization methods
- Design embedded systems with common design and analysis tools
- Design power-optimized embedded systems

Methodological competence
The students:
- Model systems with a hardware description language
- Analyze and model hardware components
- Perform multi-dimensional optimization of systems

Social competence
The students:
- Implement solutions of given problems in teams
- Discuss their outcomes appropriately

Self-competence
The students:
- Acknowledge the limits of their ability to cope with pressure during the modeling process of systems

Module contents
According to Moore’s Law the number of integratable transistors on a computer chip doubles every two years. In addition, new circuits are getting faster and faster. This leads not only to an increased functionality of a system, but it also increases the electrical power consumption. This electrical power consumption is problematic from two different points of view: Firstly, the electrical power must be supplied. Secondly, the resulting heat has to dissipate from the system. An increased power consumption always causes lower battery life and higher energy costs. The heat generation reduces the reliability and life of integrated circuits. The cooling (ceramic housings, cooling elements, fans, etc.) increases the system's costs. Today the development of heat, caused by power dissipation, needs to be considered during the embedded system design process. This knowledge takes the system’s reliability and operation costs into account. This module introduces the estimation of power dissipation and optimisation.

Recommended reading
- Designing CMOS Circuits for Low Power – Dimitros Soudris, Christian Piguet, Costas Goutis
- Leakage in Nanometer CMOS Technologies – Siva G. Narendra, Anantha Chandrakasan
- Entwurf von digitalen Schaltungen und Systemen mit HDLs und FPGAs – F. Kessel, 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

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- Fundamentals of Computer Engineering,  
- Embedded Systems I,  
- Embedded Systems II |

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Total module attendance time 56 h
## inf350 - Special Topics in 'Safety-Critical Systems' I

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</tr>
<tr>
<td></td>
<td>• recognise and evaluate applied techniques and methods of their subject and are aware of their limits</td>
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<tr>
<td></td>
<td>• identify, structure and solve problems/tasks, also in new or developing subject areas</td>
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<td></td>
<td>• apply state of the art and innovative methods to solve problems, if necessary from other disciplines</td>
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<td>• are aware of the current limits and contribute to the development of computer science research and technology</td>
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<td>• discuss and evaluate recent computer science developments</td>
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<td>The students:</td>
</tr>
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<td></td>
<td>• evaluate and apply tools, technology and methods sophisticatedly</td>
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<td>• combine new and original approaches and methods creatively - evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</td>
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<td>The students:</td>
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<td>• support team process by their abilities</td>
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<td>The students:</td>
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<td>• pursue the overall and special computer science development critically</td>
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<td>• implement innovative professional activities effectively and independently</td>
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**inf351 - Special Topics in 'Safety-Critical Systems' II**

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| Skills to be acquired in this module | This module integrates current developments in the field in adequate study courses. **Professional competences**  
  The students:  
  - define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general  
  - recognise and evaluate applied techniques and methods of their subject and are aware of their limits  
  - identify, structure and solve problems/tasks, also in new or developing subject areas  
  - apply state of the art and innovative methods to solve problems, if necessary from other disciplines  
  - are aware of the current limits and contribute to the development of computer science research and technology  
  - discuss and evaluate recent computer science developments  
  **Methodological competences**  
  The students:  
  - evaluate and apply tools, technology and methods sophisticatedly  
  - combine new and original approaches and methods creatively  
  - evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research  
  **Social competences**  
  The students:  
  - support team process by their abilities  
  **Self-competences**  
  The students:  
  - pursue the overall and special computer science development critically  
  - implement innovative professional activities effectively and independently |
<p>| Module contents | See assigned course description, e.g. „Sicherheitsanalysetechniken“, „Modellbasierter Systementwurf“, ... |
| Recommended reading | As announced in course |
| Links | |
| Language of instruction | German |
| Duration (semesters) | 1 Semester |
| Module frequency | semi-annually |
| Module capacity | unlimited |
| Module level | |
| Type of module | |
| Teaching/Learning method | 2 event from V, Ü, S, P, PR |
| Previous knowledge | none |
| Examination | Examination times |
| Final exam of module | Portfolio or presentation or oral exam |
| Type of course | VA-Auswahl |</p>
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inf352 - Current Topics in 'Safety-Critical Systems' I

Module label: Current Topics in 'Safety-Critical Systems' I
Module abbreviation: inf352
Credit points: 3.0 KP
Workload: 90 h

Applicability of the module:
- Master's Programme Computing Science (Master) > Technische Informatik

Responsible persons:
- Fränzle, Martin Georg (module responsibility)
- Lehrenden, Die im Modul (authorised to take exams)

Prerequisites: No participant requirements

Skills to be acquired in this module:
This module aims to integrate current developments in the specialization area "Safety Critical Systems" into the course of study in the appropriate course forms.

Professional competences
The students:
- define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general
- recognise and evaluate applied techniques and methods of their subject and are aware of their limits
- identify, structure and solve problems/tasks, also in new or developing subject areas
- apply state of the art and innovative methods to solve problems, if necessary from other disciplines
- are aware of the current limits and contribute to the development of computer science research and technology
- discuss and evaluate recent computer science developments

Methodological competences
The students:
- examine tasks with technical and research literature, write an academic article and present their solutions academically
- evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research
- schedule time processes and resources

Social competences
The students:
- communicate with users and experts convincingly

Self-competences
The students:
- pursue the overall and special computer science development critically
- develop and reflect self-developed hypotheses to theories independently

Module contents: See assigned course description
Recommended reading: As announced in course

Language of instruction: German
Duration (semesters): 1 Semester
Module frequency: irregular
Module capacity: unlimited
Module level:

Type of module:
1S or 1VL

Previous knowledge:
none

Examination:
Examination times
Type of examination
Final exam of module:
At the end of the lecture period
Presentation or oral exam
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### inf353 - CurrentTopics in 'Safety-Critical Systems' II

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#### Skills to be acquired in this module

This module integrates current developments in the field in adequate study courses.

**Professional competences**

The students:

- define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general
- recognise and evaluate applied techniques and methods of their subject and are aware of their limits
- identify, structure and solve problems/tasks, also in new or developing subject areas
- apply state of the art and innovative methods to solve problems, if necessary from other disciplines
- are aware of the current limits and contribute to the development of computer science research and technology
- discuss and evaluate recent computer science developments

**Methodological competences**

The students:

- examine tasks with technical and research literature, write an academic article and present their solutions academically
- evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research
- schedule time processes and resources

**Social competences**

The students:

- communicate with users and experts convincingly

**Self-competences**

The students:

- pursue the overall and special computer science development critically
- develop and reflect self-developed hypotheses to theories independently

#### Module contents

See assigned course description

#### Recommended reading

As announced in course

#### Languages of instruction

German, English

#### Duration (semesters)

1 Semester

#### Module frequency

irregular

#### Module capacity

unlimited

#### Module level

#### Type of module

1S or 1VL

#### Teaching/Learning method

none

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#### Type of course

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

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**Skills to be acquired in this module**

This module integrates current developments in the field in adequate study courses.

**Professional competences**

The students:

- define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general
- recognise and evaluate applied techniques and methods of their subject and are aware of their limits
- identify, structure and solve problems/tasks, also in new or developing subject areas
- apply state of the art and innovative methods to solve problems, if necessary from other disciplines
- are aware of the current limits and contribute to the development of computer science research and technology
- discuss and evaluate recent computer science developments

**Methodological competences**

The students:

- evaluate and apply tools, technology and methods sophisticatedly
- combine new and original approaches and methods creatively
- evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research

**Social competences**

The students:

- support team process by their abilities

**Self-competences**

The students:

- pursue the overall and special computer science development critically
- implement innovative professional activities effectively and independently

**Module contents**

See assigned course description, e.g. „Modellbasierter Systementwurf“, „Konstruktionsprinzipien ausgewählter Klassen von Fahrzeugfunktionen“

**Recommended reading**

As announced in course

**Languages of instruction**

German, English

**Duration (semesters)**

1 Semester

**Module frequency**

semi-annually

**Module capacity**

unlimited

**Module level**

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inf355 - Special Topics in 'Hybrid Systems' II

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<td>- implement innovative professional activities effectively and independently</td>
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</table>

Module contents | See assigned course description |

Recommended reading | As announced in course |

Languages of instruction | German, English |

Duration (semesters) | 1 Semester |

Module frequency | irregular |

Module capacity | unlimited |

Module level | |

Type of module | |

Teaching/Learning method | 2 event from V, Ü, S, P, PR |

Previous knowledge | none |

Examination | |

Examination times | |

Type of examination | Exercises or presentation or oral exam |

Final exam of module | At the end of the lecture period |

Type of course | VA-Auswahl |

Languages of instruction | German, English |

Module frequency | irregular |

Module capacity | unlimited |

Module level | |

Type of module | |

Teaching/Learning method | 2 event from V, Ü, S, P, PR |

Previous knowledge | none |

Examination | |

Examination times | |

Type of examination | Exercises or presentation or oral exam |

Final exam of module | At the end of the lecture period |

Type of course | VA-Auswahl |
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inf356 - Current Topics in 'Hybrid Systems' I

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### inf357 - Current Topics in 'Hybrid System' II

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

Module label: Special Topics in 'Hardware/Software Systems' I
Module abbreviation: inf358
Credit points: 6.0 KP
Workload: 180 h

Applicability of the module:
- Master's Programme Computing Science (Master) > Technische Informatik

Responsible persons:
- Fränzle, Martin Georg (module responsibility)
- Lehrenden, Die im Modul (authorised to take exams)

Prerequisites:
No participant requirements

Skills to be acquired in this module:
This module integrates current developments in the field in adequate study courses.

Professional competences:
The students:
- define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general
- recognise and evaluate applied techniques and methods of their subject and are aware of their limits
- identify, structure and solve problems/tasks, also in new or developing subject areas
- apply state of the art and innovative methods to solve problems, if necessary from other disciplines
- are aware of the current limits and contribute to the development of computer science research and technology
- discuss and evaluate recent computer science developments

Methodological competences:
The students:
- evaluate and apply tools, technology and methods sophisticatedly
- combine new and original approaches and methods creatively
- evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research

Social competences:
The students:
- support team process by their abilities

Self-competences:
The students:
- pursue the overall and special computer science development critically
- implement innovative professional activities effectively and independently

Module contents:
See assigned course description, e.g. „Spezifikation und Modellierung Eingebetteter Systeme“

Recommended reading:
As announced in course

Language of instruction: German

Duration (semesters):
1 Semester

Module frequency:
semi-annually

Module capacity:
unlimited

Module level:

Type of module:

Teaching/Learning method:
2 events from V, Ü, S, P, PR

Previous knowledge:
one

Examination:

Examination times:

Type of examination:

Final exam of module:
The exam period will be announced during the course

Portfolio or presentation or oral exam
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inf359 - Special Topics in 'Hardware/Software Systems' II

Module label
Special Topics in 'Hardware/Software Systems' II

Module abbreviation
inf359

Credit points
6.0 KP

Workload
180 h

Applicability of the module
- Master's Programme Computing Science (Master) > Technische Informatik

Responsible persons
- Fränzle, Martin Georg (module responsibility)
- Lehrenden, Die im Modul (authorised to take exams)

Prerequisites
No participant requirements

Skills to be acquired in this module
This module integrates current developments in the field in adequate study courses.

Professional competences
The students:
- define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general
- recognise and evaluate applied techniques and methods of their subject and are aware of their limits
- identify, structure and solve problems/tasks, also in new or developing subject areas
- apply state of the art and innovative methods to solve problems, if necessary from other disciplines
- are aware of the current limits and contribute to the development of computer science research and technology
- discuss and evaluate recent computer science developments

Methodological competences
The students:
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- combine new and original approaches and methods creatively
- evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research

Social competences
The students:
- support team process by their abilities

Self-competences
The students:
- pursue the overall and special computer science development critically
- implement innovative professional activities effectively and independently

Module contents
See assigned course description, e.g. „Spezifikation und Modellierung Eingebetteter Systeme”

Recommended reading
As announced in course

Links

Language of instruction
German

Duration (semesters)
1 Semester

Module frequency
irregular

Module capacity
unlimited

Module level

Type of module

Teaching/Learning method
2 events from V, Ü, S, P, PR

Previous knowledge
none

Examination

Examination times

Type of examination

Final exam of module
The exam period will be announced during the course

Exercices or presentation or oral exam
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inf360 - CurrentTopics in 'Hardware/Software Systems' I

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<td>3.0 KP</td>
</tr>
<tr>
<td>Workload</td>
<td>90 h</td>
</tr>
</tbody>
</table>

**Applicability of the module**
- Master's Programme Computing Science (Master) > Technische Informatik

**Responsible persons**
- Fränzle, Martin Georg (module responsibility)
- Lehrenden, Die im Modul (authorised to take exams)

**Prerequisites**
- No participant requirements

**Skills to be acquired in this module**
This module integrates current developments in the field in adequate study courses.

**Professional competences**
- The students:
  - define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general
  - recognise and evaluate applied techniques and methods of their subject and are aware of their limits
  - identify, structure and solve problems/tasks, also in new or developing subject areas
  - apply state of the art and innovative methods to solve problems, if necessary from other disciplines
  - are aware of the current limits and contribute to the development of computer science research and technology
  - discuss and evaluate recent computer science developments

**Methodological competences**
- The students:
  - examine tasks with technical and research literature, write an academic article and present their solutions academically
  - evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research
  - schedule time processes and resources

**Social competences**
- The students:
  - communicate with users and experts convincingly

**Self-competences**
- The students:
  - pursue the overall and special computer science development critically
  - develop and reflect self-developed hypotheses to theories independently

**Module contents**
See assigned course description, e.g. Energieeffizienz in der IKT, Smart Resource Integration, ...

**Recommended reading**
- As announced in course

**Language of instruction**
- German

**Duration (semesters)**
- 1 Semester

**Module frequency**
- irregular

**Module capacity**
- unlimited

**Module level**

**Type of module**
- Teaching/Learning method: 1S or 1VL

**Previous knowledge**
- none

**Examination**
- Examination times
- Type of examination

**Final exam of module**
- At the end of the lecture period
- Presentation or oral exam
<table>
<thead>
<tr>
<th>Type of course</th>
<th>VA-Auswahl</th>
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</thead>
<tbody>
<tr>
<td>SWS</td>
<td>2</td>
</tr>
<tr>
<td>Frequency</td>
<td>SoSe oder WiSe</td>
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<tr>
<td>On-site workload</td>
<td>28 h</td>
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</table>
inf361 - Current Topics in 'Hardware/Software Systems' II

Module label: Current Topics in 'Hardware/Software Systems' II
Module abbreviation: inf361
Credit points: 3.0 KP
Workload: 90 h

Applicability of the module:
- Master's Programme Computing Science (Master) > Technische Informatik

Responsible persons:
- Lehrenden, Die im Modul (authorised to take exams)

Prerequisites:
No participant requirements

Skills to be acquired in this module:
This module integrates current developments in the field in adequate study courses.

Professional competences:
The students:
- define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general
- recognise and evaluate applied techniques and methods of their subject and are aware of their limits
- identify, structure and solve problems/tasks, also in new or developing subject areas
- apply state of the art and innovative methods to solve problems, if necessary from other disciplines
- are aware of the current limits and contribute to the development of computer science research and technology
- discuss and evaluate recent computer science developments

Methodological competences:
The students:
- examine tasks with technical and research literature, write an academic article and present their solutions academically
- evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research
- schedule time processes and resources

Social competences:
The students:
- communicate with users and experts convincingly

Self-competences:
The students:
- pursue the overall and special computer science development critically
- develop and reflect self-developed hypotheses to theories independently

Module contents:
See assigned course description, e.g. „Energieeffizienz in der IKT“, „Smart Resource Integration“, ...

Recommended reading:
As announced in course

Language of instruction: German
Duration (semesters): 1 Semester
Module frequency: irregular
Module capacity: unlimited

Module level:

Type of module:

Teaching/Learning method: 1S or 1VL
Previous knowledge: none

Examination:
Examination times
Type of examination

Final exam of module:
At the end of the lecture period
As announced in the according course

Type of course:
Course or seminar
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</table>
inf366 - Special Topics in ‘Microrobotics and Control Engineering’ I

<table>
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<tr>
<th>Module label</th>
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<td>Module abbreviation</td>
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<td>Credit points</td>
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<td>Workload</td>
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<td>- Fatikow, Sergej (module responsibility)</td>
</tr>
<tr>
<td></td>
<td>- Lehrenden, Die im Modul (authorised to take exams)</td>
</tr>
<tr>
<td>Prerequisites</td>
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<td>Skills to be acquired in this module</td>
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<tr>
<td></td>
<td><strong>Professional competences</strong></td>
</tr>
<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>- define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general</td>
</tr>
<tr>
<td></td>
<td>- recognise and evaluate applied techniques and methods of their subject and are aware of their limits</td>
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<tr>
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<td>- identify, structure and solve problems/tasks, also in new or developing subject areas</td>
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<td></td>
<td>- apply state of the art and innovative methods to solve problems, if necessary from other disciplines</td>
</tr>
<tr>
<td></td>
<td>- are aware of the current limits and contribute to the development of computer science research and technology</td>
</tr>
<tr>
<td></td>
<td>- discuss and evaluate recent computer science developments</td>
</tr>
<tr>
<td></td>
<td><strong>Methodological competences</strong></td>
</tr>
<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>- evaluate and apply tools, technology and methods sophisticatedly</td>
</tr>
<tr>
<td></td>
<td>- combine new and original approaches and methods creatively</td>
</tr>
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<td></td>
<td>- evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</td>
</tr>
<tr>
<td></td>
<td><strong>Social competences</strong></td>
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<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>- support team process by their abilities</td>
</tr>
<tr>
<td></td>
<td><strong>Self-competences</strong></td>
</tr>
<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>- pursue the overall and special computer science development critically</td>
</tr>
<tr>
<td></td>
<td>- implement innovative professional activities effectively and independently</td>
</tr>
<tr>
<td>Module contents</td>
<td>See assigned course description, e.g. „Nanomontage und Nanohandhabung“</td>
</tr>
<tr>
<td>Recommended reading</td>
<td>As announced in course</td>
</tr>
<tr>
<td>Links</td>
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<td>Teaching/Learning method</td>
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<td>Examination</td>
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<tr>
<td>Examination times</td>
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<tr>
<td>Type of examination</td>
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<td><strong>Frequency</strong></td>
<td>SoSe oder WiSe</td>
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### inf367 - Special Topics in 'Microrobotics and Control Engineering' II

<table>
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<th>Special Topics in 'Microrobotics and Control Engineering' II</th>
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<tbody>
<tr>
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#### Applicability of the module
- Master's Programme Computing Science (Master) > Technische Informatik

#### Responsible persons
- Fatikow, Sergej (module responsibility)
- Lehrenden, Die im Modul (authorised to take exams)

#### Prerequisites
- No participant requirements

#### Skills to be acquired in this module
This module integrates current developments in the field in adequate study courses.

**Professional competences**
The students:
- define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general
- recognise and evaluate applied techniques and methods of their subject and are aware of their limits
- identify, structure and solve problems/tasks, also in new or developing subject areas
- apply state of the art and innovative methods to solve problems, if necessary from other disciplines
- are aware of the current limits and contribute to the development of computer science research and technology
- discuss and evaluate recent computer science developments

**Methodological competences**
The students:
- evaluate and apply tools, technology and methods sophisticatedly
- combine new and original approaches and methods creatively
- evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research

**Social competences**
The students:
- support team process by their abilities

**Self-competences**
The students:
- pursue the overall and special computer science development critically
- implement innovative professional activities effectively and independently

#### Module contents
See assigned course description

#### Recommended reading
As announced in course

#### Language of instruction
German

#### Duration (semesters)
1 Semester

#### Module frequency
irregular

#### Module capacity
unlimited

#### Module level

#### Type of module

#### Teaching/Learning method
2 events from V, S, Ü, P, PR

#### Previous knowledge
none

#### Examination
<table>
<thead>
<tr>
<th>Examination</th>
<th>Examination times</th>
<th>Type of examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final exam of module</td>
<td>The exam period will be announced during the course</td>
<td>Portfolio or presentation or oral exam</td>
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**Type of course**
VA-Auswahl
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inf368 - Current Topics in 'Microrobotics and Control Engineering' I

<table>
<thead>
<tr>
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<th>Current Topics in 'Microrobotics and Control Engineering' I</th>
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<tbody>
<tr>
<td>Module abbreviation</td>
<td>inf368</td>
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<td>Workload</td>
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<td>Applicability of the module</td>
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<tr>
<td>Responsible persons</td>
<td>Fatikow, Sergej (module responsibility) Lehrenden, Die im Modul (authorised to take exams)</td>
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<td>Prerequisites</td>
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<td>Skills to be acquired in this module</td>
<td>This module integrates current developments in the field in adequate study courses.</td>
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<tr>
<td>Professional competences</td>
<td>The students:</td>
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<td>- evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</td>
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<td></td>
<td>- schedule time processes and resources</td>
</tr>
<tr>
<td>Social competences</td>
<td>The students:</td>
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<tr>
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<td>Self-competences</td>
<td>The students:</td>
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<tr>
<td></td>
<td>- develop and reflect self-developed hypotheses to theories independently</td>
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Module contents | See assigned course description |
Recommended reading | As announced in course |
Links
Language of instruction | German |
Duration (semesters) | 1 Semester |
Module frequency | irregular |
Module capacity | unlimited |
Module level
Type of module
Teaching/Learning method | 1S or 1VL |
Previous knowledge | none |
Examination
Examination times
Type of examination
Final exam of module | At the end of the lecture period Presentation or oral exam |
Type of course | Course or seminar |
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<thead>
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<td>Frequency</td>
<td>WiSe</td>
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<td>On-site workload</td>
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### inf369 - Current Topics in 'Microrobotics and Control Engineering' II

<table>
<thead>
<tr>
<th>Module label</th>
<th>Current Topics in 'Microrobotics and Control Engineering' II</th>
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<tbody>
<tr>
<td>Module abbreviation</td>
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<tr>
<td>Credit points</td>
<td>3.0 KP</td>
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<td>Workload</td>
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<tr>
<td>Applicability of the module</td>
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</table>
| Responsible persons | • Fatikow, Sergej (module responsibility)  
• Lehrenden, Die im Modul (authorised to take exams) |
| Prerequisites | No participant requirements |
| Skills to be acquired in this module | This module integrates current developments in the field in adequate study courses. |
| Professional competences | The students: |
| | • define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general |
| | • recognise and evaluate applied techniques and methods of their subject and are aware of their limits |
| | • identify, structure and solve problems/tasks, also in new or developing subject areas |
| | • apply state of the art and innovative methods to solve problems, if necessary from other disciplines |
| | • are aware of the current limits and contribute to the development of computer science research and technology |
| | • discuss and evaluate recent computer science developments |
| Methodological competences | The students: |
| | • examine tasks with technical and research literature, write an academic article and present their solutions academically |
| | • evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research |
| | • schedule time processes and resources |
| Social competences | The students: |
| | • communicate with users and experts convincingly |
| Self-competences | The students: |
| | • pursue the overall and special computer science development critically |
| | • develop and reflect self-developed hypotheses to theories independently |

<p>| Module contents | See assigned course description |
| Recommended reading | As announced in course |
| Links | |
| Language of instruction | German |
| Duration (semesters) | 1 Semester |
| Module frequency | irregular |
| Module capacity | unlimited |
| Module level | |
| Type of module | |
| Teaching/Learning method | 1S or 1VL |
| Previous knowledge | none |
| Examination | Examination times |
| Final exam of module | At the end of the lecture period |
| Type of course | Course or seminar |</p>
<table>
<thead>
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<tr>
<td><strong>Frequency</strong></td>
<td>SoSe oder WiSe</td>
</tr>
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<td><strong>On-site workload</strong></td>
<td>28 h</td>
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</table>
inf374 - Special Topics in 'Automotive' I

<table>
<thead>
<tr>
<th>Module label</th>
<th>Special Topics in 'Automotive' I</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module abbreviation</td>
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<td>Credit points</td>
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<td>Applicability of the module</td>
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<td>Responsible persons</td>
<td>Hein, Andreas (module responsibility)</td>
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<td>Lehrenden, Die im Modul (authorised to take exams)</td>
</tr>
<tr>
<td>Prerequisites</td>
<td>No participant requirements</td>
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<tr>
<td>Skills to be acquired in this module</td>
<td>This module integrates current developments in the field in adequate study courses.</td>
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<tr>
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<td><strong>Professional competences</strong></td>
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<tr>
<td></td>
<td>The students:</td>
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<td></td>
<td><strong>Social competences</strong></td>
</tr>
<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>• support team process by their abilities</td>
</tr>
<tr>
<td></td>
<td><strong>Self-competences</strong></td>
</tr>
<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>• pursue the overall and special computer science development critically</td>
</tr>
<tr>
<td></td>
<td>• implement innovative professional activities effectively and independently</td>
</tr>
<tr>
<td>Module contents</td>
<td>See assigned course description, e.g. „Zielarchitekturen Eingebetteter Systeme für Automotive-Anwendungen“</td>
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<tr>
<td>Recommended reading</td>
<td>As announced in course</td>
</tr>
<tr>
<td>Links</td>
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<td>Examination times</td>
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<td>Type of examination</td>
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<tr>
<td>Final exam of module</td>
<td>Portfolio or presentation or oral exam</td>
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<tr>
<td>Type of course</td>
<td>VA-Auswahl</td>
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inf375 - Special Topics in 'Automotive' II

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<tbody>
<tr>
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<td>Responsible persons</td>
<td>• Hein, Andreas (module responsibility)</td>
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<td><strong>Professional competences</strong></td>
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<td></td>
<td>• define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general</td>
</tr>
<tr>
<td></td>
<td>• recognise and evaluate applied techniques and methods of their subject and are aware of their limits</td>
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<tr>
<td></td>
<td>• identify, structure and solve problems/tasks, also in new or developing subject areas</td>
</tr>
<tr>
<td></td>
<td>• apply state of the art and innovative methods to solve problems, if necessary from other disciplines</td>
</tr>
<tr>
<td></td>
<td>• are aware of the current limits and contribute to the development of computer science research and technology</td>
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<tr>
<td></td>
<td>• discuss and evaluate recent computer science developments</td>
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<td><strong>Methodological competences</strong></td>
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<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>• evaluate and apply tools, technology and methods sophisticatedly</td>
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<tr>
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<td>• combine new and original approaches and methods creatively</td>
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<td>• evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research</td>
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<td><strong>Social competences</strong></td>
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<tr>
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<td>The students:</td>
</tr>
<tr>
<td></td>
<td>• Support team process by their abilities</td>
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<td><strong>Self-competences</strong></td>
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<td>The students:</td>
</tr>
<tr>
<td></td>
<td>• pursue the overall and special computer science development critically</td>
</tr>
<tr>
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<td>• implement innovative professional activities effectively and independently</td>
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## inf376 - Current Topics in 'Automotive' I

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<tr>
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<td>Credit points</td>
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<td>Applicability of the module</td>
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<td>Hein, Andreas (module responsibility)</td>
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<td>Skills to be acquired in this module</td>
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### Professional competences
The students:
- define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general
- recognise and evaluate applied techniques and methods of their subject and are aware of their limits
- identify, structure and solve problems/tasks, also in new or developing subject areas
- apply state of the art and innovative methods to solve problems, if necessary from other disciplines
- are aware of the current limits and contribute to the development of computer science research and technology
- discuss and evaluate recent computer science developments

### Methodological competences
The students:
- examine tasks with technical and research literature, write an academic article and present their solutions academically
- evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research
- schedule time processes and resources

### Social competences
The students:
- communicate with users and experts convincingly

### Self-competences
The students:
- pursue the overall and special computer science development critically
- develop and reflect self-developed hypotheses to theories independently

<table>
<thead>
<tr>
<th>Module contents</th>
<th>See assigned course description</th>
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</thead>
<tbody>
<tr>
<td>Recommended reading</td>
<td>As announced in course</td>
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<td>Duration (semesters)</td>
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<td>Examination times</td>
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<td>Course or seminar</td>
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Language of instruction: German
Duration (semesters): 1 Semester
Module frequency: irregular
Module capacity: unlimited
Module level:
Type of module: 
Teaching/Learning method: 1S or 1VL
Previous knowledge: none
Examination: 
Examination times: 
Type of examination: 
Final exam of module: At the end of the lecture period
Type of course: Course or seminar
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inf377 - Current Topics in 'Automotive' II

Module label
Current Topics in 'Automotive' II

Module abbreviation
inf377

Credit points
3.0 KP

Workload
90 h

Applicability of the module
- Master's Programme Computing Science (Master) > Technische Informatik

Responsible persons
- Lehrenden, Die im Modul (module responsibility)
- Lehrenden, Die im Modul (authorised to take exams)

Prerequisites
No participant requirements

Skills to be acquired in this module
This module integrates current developments in the field in adequate study courses.

Professional competences
The students:
- define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general
- recognise and evaluate applied techniques and methods of their subject and are aware of their limits
- identify, structure and solve problems/tasks, also in new or developing subject areas
- apply state of the art and innovative methods to solve problems, if necessary from other disciplines
- are aware of the current limits and contribute to the development of computer science research and technology
- discuss and evaluate recent computer science developments

Methodological competences
The students:
- examine tasks with technical and research literature, write an academic article and present their solutions academically
- evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research
- schedule time processes and resources

Social competences
The students:
- communicate with users and experts convincingly

Self-competences
The students:
- pursue the overall and special computer science development critically
- develop and reflect self-developed hypotheses to theories independently

Module contents
See assigned course description

Recommended reading
As announced in course

Language of instruction
German

Duration (semesters)
1 Semester

Module frequency
irregular

Module capacity
unlimited

Module level

Type of module
Teaching/Learning method
1S or 1VL

Previous knowledge
none

Examination
Examination times
Type of examination

Final exam of module
At the end of the lecture period
Presentation or oral exam

Type of course
Course or seminar
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<td>On-site workload</td>
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inf453 - Combination of Specification Techniques

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<td>Credit points</td>
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<td>Workload</td>
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<td>• Master's Programme Computing Science (Master) &gt; Theoretische Informatik</td>
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<td>• Olderog, Ernst-Rüdiger (module responsibility)</td>
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<td>• Lehrenden, Die im Modul (authorised to take exams)</td>
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<tr>
<td>Prerequisites</td>
<td>• inf440 Theoretical Computer Science I</td>
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<td>• inf441 Theoretical Computer Science II</td>
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<tr>
<td>Skills to be acquired in this module</td>
<td>Introduction to the specification languages Z for data, CSP for processes, and their combination CSP-OZ for reactive systems with data and process parts.</td>
</tr>
<tr>
<td>Professional competence</td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>• specify data and processes with Z, CSP and CSP-OZ formally</td>
</tr>
<tr>
<td></td>
<td>• check data refinement relations formally</td>
</tr>
<tr>
<td></td>
<td>• verify CSP-OZ specifications with FDR model checker</td>
</tr>
<tr>
<td>Methodological competence</td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>• are able to integrate complementary specification methods</td>
</tr>
<tr>
<td>Social competence</td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>• work together in small groups to solve problems</td>
</tr>
<tr>
<td></td>
<td>• present solutions to problems to groups of other students</td>
</tr>
<tr>
<td>Self-competence</td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>• learn persistence in pursuing difficult tasks</td>
</tr>
<tr>
<td></td>
<td>• learn precision in specifying problems</td>
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Module contents

The course addresses a research trend in formal methods, the combination and integration of different specification methods. It focuses on a concrete combination CSP-OZ of the specification techniques CSP (Communicating Sequential Processes) for processes and Z and Object-Z for data, respectively. Reactive systems are described by CSP-OZ. As a preparation, the specification languages Z and CSP are described, followed by the combination CSP-OZ with its process-oriented semantics. The concepts of refinement and inheritance and the possibility of automatic verification of a sublanguage of CSP-OZ with the FDR model checker for CSP will be discussed. Finally, the course explains possibilities of extending CSP-OZ for the specification of time-critical systems.

Topics:

• specification of complex data and operations in Z, type definition and pattern calculations of Z, data refinement
• specifications of communicating processes in CSP, operational semantics of CSP, three abstract semantic models for CSP: Trace semantics, failures semantics, failures-divergences semantics, process refinement in the above semantics, FDR model checker for CSP
• combined specification method CSP-OZ, transformational semantics as CSP-process, theorems of refinements, object-oriented concepts of class and inheritance in CSP-OZ

Recommended reading

Essential:

Recommended:


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<tr>
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<tr>
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| Previous knowledge | - inf400 Theoretical Computer Science I  
- inf401 Theoretical Computer Science II |

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<td>exercises and oral exam</td>
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<td>14</td>
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| Total module attendance time | 56 h |
inf454 - Communicating and Mobile Systems

Module label: Communicating and Mobile Systems
Module abbreviation: inf454
Credit points: 6.0 KP
Workload: 180 h

Applicability of the module:
- Master's Programme Computing Science (Master) > Theoretische Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Responsible persons:
- Olderog, Ernst-Rüdiger (module responsibility)
- Lehrenden, Die im Modul (authorised to take exams)

Prerequisites:
No participant requirements

Skills to be acquired in this module:
- Introduction to Milner's Calculus of Communicating Systems (CCS) and the ?-calculus.

Professional competence
The students:
- know the theory of the operational semantics of CCS and the ?-calculus
- Perform equivalence proofs using simulations and bisimulations
- specify communicating and mobile systems with CCS and the ?-calculus

Methodological competence
The students:
- learn about different views on mobility
- recognize equivalences as formal means for system correctness

Social competence
The students:
- work together in small groups to solve problems
- present their solutions to groups of other students

Self-competence
The students:
- learn persistence in pursuing difficult tasks
- learn precision in specifying problems

Module contents:
Communication is one of the basic concepts of computer science. It occurs between computers in a network as well as between components of a computer. The focus of the course is on Robin Milner's ?-calculus. It enables a new modelling of communication, taking the location of the communication into account. The ?-calculus can describe the change of data in a computer as well as the sending of messages or even programs along networks like the internet. It is also possible to describe reconfigurable networks. This will be shown using the examples of mobile phones, schedulers, automatic vending machines, data structures, communication protocols, and objects in object-oriented programming. All these applications are backed by the theory of the ?-calculus, which is based on operational semantics and a concept of behavioural equivalence. The theory will be explained in a step-by-step manner.

Topics:
- different views on mobility
- transition systems with simulations and bisimulations
- Milner's Calculus of Communicating Systems (CCS) and Milner's ?-calculus for mobile systems, both with operational semantics, structural congruence, strong equivalence and observational equivalence, relationship between reactions and transitions, solvability of recursive equations
- formal specification of examples of communicating and mobile systems using CCS and the ?-calculus
- proof of strong equivalence and observational equivalence of given processes
- specification of dynamic data structures in the ?-calculus

Recommended reading

Links

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Module level

Type of module

Teaching/Learning method | 1VL + 1Ü
Previous knowledge       | Theoretical Computer Science II

Examination

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Final exam of module

Type of course

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Total module attendance time

| Total module attendance time |
| 56 h |
inf456 - Real-Time Systems

Module label Real-Time Systems
Module abbreviation inf456
Credit points 6.0 KP
Workload 180 h

Applicability of the module
- Master's Programme Computing Science (Master) > Theoretische Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Responsible persons
- Olderog, Ernst-Rüdiger (module responsibility)
- Lehrenden, Die im Modul (authorised to take exams)

Prerequisites
Theoretical Computer Science I + II

Skills to be acquired in this module
Introduction to formal methods of the specification and verification of time sensitive systems and their combinations.

Professional competence
The students:
- learn about different models of time and real-time properties
- specify and verify real-time systems
- model real-time systems using Timed Automata and PLC-Automata
- apply the model checker UPPAAL for the verification of real-time properties
- specify real-time systems using the Duration Calculus
- learn about decidability and undecidability results for real-time systems

Methodological competence
The students:
- recognize logic and automata as adequate forms for describing real-time systems

Social competence
The students:
- work together in small groups to solve problems
- present their solutions to groups of other students

Self-competence
The students:
- learn persistence in pursuing difficult tasks
- learn precision in specifying problems

Module contents
Examples of time-critical systems are railway control systems, robots, or even gas burners. It is essential for these systems to comply with certain timing conditions. For example, the control of a railway crossing must close the gates not later than 4 seconds after the sensors have reported an approaching train. If the gates are open, they should stay that way for at least 15 seconds to allow for a safe crossing of vehicles. Different specification methods have been developed to describe such timing conditions. The Duration Calculus developed by Zhou Chaochen in 1991 is one attractive method. It is a logic combined with a calculus, in which the duration of states can be described. The course will introduce the Duration Calculus and will explain its application by means of examples. As further specification method Timed Automata introduced by Alur & Dill in 1994 will be presented. After the specification of real-time system requirements the verification of programs implementing these requirements will follow. The specification methods of the Duration Calculus and Timed Automata are used to describe the real-time behaviour of these programs. The correctness is then proven on the basis of these behavioral descriptions.

Topics:
- discrete and continuous model of time
- logics and automata models for the specification of real-time systems (predicate logic, Duration Calculus, Timed CTL, Timed Automata, PLC-Automata)
- decidability and undecidability results for real-time systems
- model checker UPPAAL for Timed Automata
formal specification of real-time systems using Duration Calculus as well as Timed Automata and PLC-Automata
verification of concrete Timed Automata using the model checker UPPAAL,
transformation of Duration Calculus for discrete time into regular languages
implementability of real-time systems on PLC-like hardware

Recommended reading

Essential:

Recommended:

Links

Languages of Instruction: German, English
Duration (semesters): 1 Semester
Module frequency: irregular
Module capacity: unlimited
Module level:
Type of module:
Teaching/Learning method: 1VL + 1Ü
Previous knowledge: Theoretical Computer Science I + II
Examination:
Examination times: At the end of the lecture period
Type of examination: Exercises and written or oral exam

Final exam of module

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Total module attendance time: 56 h
inf513 - Energy Informatics Lab

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**Applicability of the module**
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik

**Responsible persons**
- Lehrenden, Die im Modul (authorised to take exams)
- Lehnhoff, Sebastian (module responsibility)

**Prerequisites**
- Programming with Java
- Programming with Python

**Skills to be acquired in this module**
Successfully completing this lecture will enable the students to mathematically model simple controllable electrical generators and consumers and to simulate them together with appropriate control algorithms within smart grid scenarios. To achieve this goal, students will start with deriving computational models from physical models and evaluate them. In order to manage the integration of control algorithms, students are taught the principles of cosimulation using the "mosaik" smart grid co-simulation framework as an example. Students will be able to understand and apply distributed, agent-based control schemes to decentralized energy generators and/ or consumers. As a result, students are able to analyze the requirements for successful application to real power balancing regarding capacity utilization, robustness, and flexibility. In addition, students learn the foundations of planning and conducting simulation based experiments as well as the interpretation of the results. Special attention will be paid on establishing a balance between the results' precision and robustness and the necessary effort (design of experiments) in order to gain as much insight into interdependencies with as few experiments as possible.

**Professional competence**
The students:
- derive and evaluate computational models from physical models
- use the "mosaik" smart grid co-simulation framework
- analyze the requirements for successful applications to real power balancing regarding capacity utilization, robustness, and flexibility
- name the foundations of planning and conducting simulation based experiments as well as the interpretation of the results
- are aware of the balance between the results' precision and robustness and the necessary effort (design of experiments) in order to gain as much insight into interdependencies with as few experiments.

**Methodological competence**
The students:
- model simple controllable electrical generators and consumers
- simulate simple controllable electrical generators and consumers with appropriate control algorithms within smart grid scenarios
- apply distributed agent-based control schemes to decentralized energy generators and/ or consumers
- evaluate simulation results
- search information and look into methods to implement models
- propose hypothesis and check their validity with design of experiments methods

**Social competence**
The students:
- apply the pair programming development technique
- discuss design decisions
- identify work packages and are responsible for it

**Self-competence**
The students:
- reflect on their own use of power as a limited resource
- accept and use criticism to develop their own behaviour
Module contents

In this practical course students:

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

Recommended reading

Suggested reading:

**Smart Grids:**

**Multiagentensysteme:**

**Co-Simulation:**

**Versuchsplanung:**
- Klein, B.: "Versuchsplanung - DoE", Oldenbourg, 2011

Links

http://mosaik.offis.de

Language of instruction

German

Duration (semesters)

1 Semester

Module frequency

annual

Module capacity

unlimited

Reference text

Elective module in the master specialization area (energy computer science).

Associated with the modules:

- Energiinformationssysteme
- Smart Grid Management

Module level

Type of module

Teaching/Learning method

1P

Previous knowledge

- Programming with Java
- Programming with Python

Examination

Examination times

Type of examination

Final exam of module

At the end of the semester

Oral exam

Type of course

Practical training

SWS

4

Frequency

SoSe

On-site workload

56 h
inf950 - Interdisciplinary Module I

<table>
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<tr>
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</thead>
<tbody>
<tr>
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<td>inf950</td>
</tr>
<tr>
<td>Credit points</td>
<td>6.0 KP</td>
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<tr>
<td>Workload</td>
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<tr>
<td>Applicability of the module</td>
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<tr>
<td>Responsible persons</td>
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</tr>
<tr>
<td>Prerequisites</td>
<td>No participant requirements</td>
</tr>
<tr>
<td>Skills to be acquired in this module</td>
<td>The graduates know the basics and the application-relevant application-relevant background of the selected discipline.</td>
</tr>
<tr>
<td></td>
<td><strong>Professional competencies</strong></td>
</tr>
<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>• identify the fundamentals and methods of the chosen field</td>
</tr>
<tr>
<td></td>
<td>• use the technical language of the field of application competently</td>
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<tr>
<td></td>
<td><strong>Methodological competencies</strong></td>
</tr>
<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>• characterize the context of use and requirements of IT in the chosen field</td>
</tr>
<tr>
<td></td>
<td>• apply the disciplinary methods and techniques of the application area and contrast them with the methods and techniques</td>
</tr>
<tr>
<td></td>
<td>• known from methods and techniques</td>
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<tr>
<td></td>
<td>• known from computer science</td>
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<tr>
<td></td>
<td>• investigate problems of an application area with the methods and techniques typical for the discipline methods</td>
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<td><strong>Social competencies</strong></td>
</tr>
<tr>
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<td>The students:</td>
</tr>
<tr>
<td></td>
<td>• can appreciate the diversity of subject cultures and</td>
</tr>
<tr>
<td></td>
<td>• respect other disciplines and their way of working</td>
</tr>
<tr>
<td></td>
<td>• prepare themselves for application scenarios for IT systems</td>
</tr>
<tr>
<td></td>
<td><strong>Self-competences</strong></td>
</tr>
<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>• reflect on their self-image and actions against the background of a other subject discipline</td>
</tr>
</tbody>
</table>

| Module contents               | The module is instituted with subject modules from other disciplines or modules of the Department of Computer Science that are instantiated as a noncomputer science module are marked as such. The course forms and examination modalities are based on the module chosen in each case. |

<table>
<thead>
<tr>
<th>Recommended reading</th>
<th>Links</th>
</tr>
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<tbody>
<tr>
<td>Languages of instruction</td>
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<tr>
<td>Teaching/Learning method</td>
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<tr>
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<td>Examination times</td>
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<tr>
<td>Type of course</td>
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<td>SoSe oder WiSe</td>
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<td>23 h</td>
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inf951 - Interdisciplinary Module II

Module label: Interdisciplinary Module II
Module abbreviation: inf951
Credit points: 6.0 KP
Workload: 180 h
Applicability of the module: Master's Programme Computing Science (Master) > Interdisziplinäre Module

Responsible persons:
Prerequisites: No participant requirements

Skills to be acquired in this module:

Fachkompetenzen
Die Studierenden:
- benennen die Grundlagen und Methoden des gewählten Gebietes
- wenden die Fachsprache des Anwendungsgebietes kompetent an

Methodenkompetenzen
Die Studierenden:
- charakterisieren Nutzungskontext und Anforderungen von IT im gewählten Gebiet
- wenden die disziplinären Methoden und Techniken des Anwendungsgebietes an und kontrastieren diese mit den aus der Informatik bekannten Methoden und Techniken
- untersuchen Probleme eines Anwendungsgebietes mit den disziplintypischen Methoden

Sozialkompetenzen
Die Studierenden:
- können die Verschiedenheit von Fachkulturen einschätzen und respektieren andere Fachgebiete und deren Arbeitsweise
- bereiten sich auf Anwendungsszenarien für IT-Systeme vor

Selbstkompetenzen
Die Studierenden:
- reflektieren ihr Selbstbild und Handeln vor dem Hintergrund einer anderen Fachdisziplin

Module contents:
Das Modul wird mit Fachmodulen aus anderen Disziplinen oder Modulen des Departments für Informatik instanziert, die als Nicht Informatik-Modul gekennzeichnet sind. Die Veranstaltungsformen und Prüfungsmodalitäten orientieren sich an dem jeweils gewählten Modul.

Recommended reading
Links

Languages of instruction

Duration (semesters): 1 Semester
Module frequency
Module capacity: unlimited
Module level
Type of module
Teaching/Learning method

Previous knowledge:

Examination
Examination times
Type of examination
Final exam of module

Type of course: VA-Auswahl

SWS
2
Frequency: SoSe oder WiSe
| On-site workload | 28 h |
inf514 - Simulation-based Smart Grid Engineering and Assessment

Module label | Simulation-based Smart Grid Engineering and Assessment
---|---
Module abbreviation | inf514
Credit points | 6.0 KP
Workload | 180 h

Applicability of the module
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's programme Digitalised Energy Systems (Master) > Computer Science and Energy Informatics

Responsible persons
- Lehnhoff, Sebastian (module responsibility)
- Lehrenden, Die im Modul (authorised to take exams)

Prerequisites
Basic programming in Java or Python

Skills to be acquired in this module
Goal of this module is to teach mathematical and methodological foundations of energy informatics and for conducting large-scale simulation studies

**Professional competence**
The students:
- know methods to analyze black-box objective functions
- recognize the relation between precision and reliability of expected results and the necessary surplus effort
- know methods to determine cause-effect relations between input parameters with small numbers of simulations (experiments)
- evaluate the significance of simulation results
- characterize (distributed) algorithms by their properties
- transfer proving techniques to distributed problems

**Methodological competence**
The students:
- choose suitable statistical methods to interpret simulation results
- apply methods from design of experiments
- apply significance tests to compare algorithms
- generate arbitrarily distributed input data
- present results from algorithm evaluation statistically sound

**Social competence**
The students:
- discuss the own algorithm choice
- present their results and discuss with other students

**Self-competence**
The students:
- reflect their own usage of the scarce resource energy
- reflect problems and uncertainties when using statistical methods
- recognize the limits of simulation studies and their responsibility for choosing correct statistical methods
- accept criticism and understand it as a suggestion for the further development of their own actions

Module contents
The goal of this module is to teach mathematical and methodological foundations of energy informatics and especially for conducting large-scale simulation studies.

Recommended reading
Will be announced in the lecture

Links
Language of instruction | English
Duration (semesters) | 1 Semester
Module frequency | every winter term
Module capacity | unlimited
Module level
Type of module | 1VL + 1Ü
Previous knowledge | Basic programming in Java or Python
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<th>Type of examination</th>
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<td>Written exam or oral exam</td>
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<th>Frequency</th>
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<td>WiSe</td>
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<tr>
<td>Exercises</td>
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<td>2</td>
<td>WiSe</td>
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**Total module attendance time** 56 h
inf515 - Intelligent Energy Systems

<table>
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<td>Module abbreviation</td>
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<td>Workload</td>
<td>180 h</td>
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<tr>
<td>Applicability of the module</td>
<td>· Master's Programme Computing Science (Master) &gt; Angewandte Informatik</td>
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</tbody>
</table>
| Responsible persons | · Bremer, Jörg (module responsibility)  
· Lehnhoff, Sebastian (module responsibility)  
· Lehrenden, Die im Modul (authorised to take exams) |
| Prerequisites | Programming knowledge in Python |
| Skills to be acquired in this module |

Das Modul befasst sich mit der Integration (verteilter) künstlicher Intelligenz in die zukünftige Steuerung des Energienetzes. Das Modul vermittelt moderne Techniken der künstlichen Intelligenz und des maschinellen Lernens als Beitrag beispielsweise in der semi-automatischen Betriebsführung von Stromnetzen, bei der von Einsicht getriebenen Vermarktung von dezentralen Energieanlagen oder bei der Prognose von Last- und Erzeugungszeitreihen

**Fachkompetenzen**

Die Studierenden

· kennen Methoden zur Modellierung der Flexibilität von Energieanlagen mittels maschinellem Lernen  
· können Flexibilitätsmodelle implementieren  
· kennen verschiedene Ansätze der Agenten-basierten Modellierung und Koordination im elektrischen Netz  
· kennen Techniken des Adversarial Resilience Learning  
· bewerten verschiedene Verfahren des Deep und Reinforcement Learning hinsichtlich ihrer Eigenschaften und Eignung in der verteilten Lastplanung  
· charakterisieren Methoden maschinellen Lernens anhand ihrer Eigenschaften

**Methodenkompetenz**

Die Studierenden

· erzeugen systematisch zulässige Lösungen mittels Einsatz von Dekodertechnik  
· wenden maschinelles Lernen in verteilten Algorithmen praktisch an

**Sozialkompetenz**

Die Studierenden

· wenden die Entwicklungsmethode des Pairprogrammings an  
· diskutieren die getroffenen Design Entscheidungen  
· präsentieren ihre Arbeitsergebnisse anderen Studierenden

**Selbstkompetenz**

Die Studierenden

· reflektieren den eigenen Umgang mit der begrenzten Ressource Energie  
· nehmen Kritik an und verstehen sie als Vorschlag für die Weiterentwicklung des eigenen Handelns  
· erkennen die gesellschaftspolitische Verantwortung beim Einsatz von Methoden der künstlichen Intelligenz

**Module contents**

In dieser Veranstaltung werden

· mathematische Grundlagen Supportvektor-basierter Modellierungstechniken vermittelt  
· geometrische Untervektorraummodellierungen vermittelt und von den Studierenden angewendet
Grundlagen verteilter Algorithmen in Energienetzen vermittelt
• das Design intelligenter Agenten mittels Reinforcement Learning und Q-Learning vermittelt und praktisch angewendet
• Grundlagen des Adversarial Resilience Learning vermittelt

Recommended reading

- Mehr wird in der Veranstaltung bekannt gegeben

Links

Languages of instruction: German, English
Duration (semesters): 1 Semester
Module frequency: every summer term
Module capacity: unlimited
Module level:
Type of module: 1VL + 1Ü
Teaching/Learning method: Programming knowledge in Python
Previous knowledge:
Examination:
Examination times: oral exam
Final exam of module:
At the end of the course

Type of course: Lecture, Exercises
Comment: SWS, Frequency: SoSe oder WiSe
Workload of compulsory attendance:
Lecture: 3, 28
Exercises: 1, 28
Total module attendance time: 56 h
inf516 - Distributed Operation in Digitalised Energy Systems

<table>
<thead>
<tr>
<th>Module label</th>
<th>Distributed Operation in Digitalised Energy Systems</th>
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</thead>
<tbody>
<tr>
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<tr>
<td>Credit points</td>
<td>6.0 KP</td>
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<tr>
<td>Workload</td>
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| Applicability of the module | - Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's programme Digitalised Energy Systems (Master) > Digitalised Energy System Automation, Control and Optimisation |
| Responsible persons | - Nieße, Astrid (module responsibility)
- Lehrenden, Die im Modul (authorised to take exams) |
| Prerequisites | Fundamentals of Optimization, Fundamentals of Digitized Energy Systems |

**Skills to be acquired in this module**

After successful completion of this course, the students are able to analyze an application problem in cyber-physical energy systems to decide whether a distributed optimization approach could be usefully applied. Fundamentals of self-organizing systems are understood and can be transferred to specific applications. Furthermore, the basic concepts of distributed methods can be applied safely and transferred to an application case.

**Professional competence**
The students:
- will be familiar with the basic concepts of distributed optimization and agent systems mentioned above

**Methodological competence**
The students:
- will be able to present the fundamental concepts of distributed optimization and agent systems mentioned above and apply them to application problems in CPES

**Social competence**
The students:
- create solutions in small teams
- present and discuss their solutions
- reflect the solutions of others in a constructive manner

**Self competence**
The students:
- critically question the application of learned methods to a real-world problem

**Module contents**

In this course, fundamentals of agent-based control with applications in cyber-physical power systems are reviewed, discussed, and reinforced in the accompanying programming exercise.

These are:

1. Multi-agent systems
   - Foundations and definitions
   - MAS architectures
   - Agent communication
   - Cooperative and competitive agents MAS
   - learning in MAS
2. Distributed Optimization
   - CASIMIR
   - Overview on distributed optimization
   - CSP and COP
   - Distributed SCP und COP
3. Self-organizing energy systems
4. Applications
5. Programming part

- Virtual Power Plants
- QEMS and Microgrids
- DSM and DR
- Energy market applications
- Swarms for storage management
- Multi-purpose examples

Recommended reading


Links

Language of instruction | English
---|---
Duration (semesters) | 1 Semester
Module frequency | every winter term
Module capacity | 50
Type of module | 
Teaching/Learning method | 1VL + 1Ü
Previous knowledge | Fundamentals of Optimization, Fundamentals of Digitized Energy Systems
Examination | Examination times
Type of examination | 
Final exam of module | In the current semester and at the end of the event
Type of course | Comment | SWS | Frequency | Workload of compulsory attendance
---|---|---|---|---
Lecture | | 2 | WiSe | 28
Exercises | | 2 | WiSe | 28
Total module attendance time | 56 h
**Frühere Module**

inf191 - Special Topics in Practical Computer Science II

<table>
<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>Module abbreviation</td>
<td>inf191</td>
</tr>
<tr>
<td>Credit points</td>
<td>6.0 KP</td>
</tr>
<tr>
<td>Workload</td>
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</tbody>
</table>

**Applicability of the module**
- Master's Programme Computing Science (Master) > Praktische Informatik

**Responsible persons**
- Peter, Andreas (module responsibility)
- Vogel-Sonnenschein, Ute (module responsibility)
- Lehrenden, Die im Modul (authorised to take exams)

**Prerequisites**
- No participant requirements

**Skills to be acquired in this module**

**Subject competences**
The students:
- differentiate and contrast a subarea of practical computer science in more detail
- recognize and assess the techniques and methods to be applied in the special field of the course and their limits
- identify, structure and solve problems also in new or emerging areas of their discipline
- recognize the limits of current knowledge and technology and contribute to the further scientific and technological development of computer science
- discuss current developments in practical computer science and assess their significance
- critically follow further developments in the special field discussed in the course.

**Methodological competencies**
The Students:
- apply state-of-the-art and innovative methods in the research and solution of problems, drawing on other disciplines where appropriate
- investigate problems on the basis of technical and scientific literature, write an article according to scientific criteria, and present their results in a scientific talk
- reflect on problems, including those in new or emerging areas of practical computer science, and apply computer science methods to investigate and solve them
- plan time schedules and other resources
- develop and reflect on their own theories on independently generated hypotheses

**Social Skills**
The Students:
- will communicate persuasively orally and in writing with users and professionals
- will solve tasks goal-oriented in a team

**Self-competencies**
The students:
- deepen their self-organization skills
- reflect self-critically on their actions and skills in the special field under consideration and assess them appropriately

**Module contents**
In this module, content and methods on current topics in practical computer science are taught.

For details on objectives and contents, please refer to the details of the assigned course or contact the lecturers directly

**Recommended reading**
depending on the course assigned
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<tr>
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<td>Teaching/Learning method</td>
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<td>Examination times</td>
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<td>Am Ende der Vorlesungszeit nach Absprache mit</td>
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<td>dem Lehrenden</td>
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</table>
inf493 - Special Topics in Theoretical Computer Science II

Module label: Special Topics in Theoretical Computer Science II
Module abbreviation: inf493
Credit points: 6.0 KP
Workload: 180 h

Applicability of the module:
- Master's Programme Computing Science (Master) > Theoretische Informatik

Responsible persons:
- Wehrheim, Heike (module responsibility)
- Lehrenden, Die im Modul (authorised to take exams)

Prerequisites:
No participant requirements

Skills to be acquired in this module:
Das Modul hat zum Ziel aktuelle Entwicklungen im Vertiefungsgebiet XYZ in den jeweils angemessenen Lehrveranstaltungsformen in das Studium zu integrieren.

Fachkompetenzen
Die Studierenden:
- differenzieren und kontrastieren einen Teilbereich der Informatik, auf den sie sich spezialisiert haben, im Detail genauer oder reflektieren die Informatik im Allgemeinen
- erkennen und beurteilen die in ihrem Spezialgebiet anzuwendenden Techniken und Methoden und deren Grenzen
- identifizieren, strukturieren und lösen Probleme auch in neuen oder erst im Entstehen begriffenen Bereichen ihrer Disziplin
- wenden dem Stand der Wissenschaft entsprechende und innovative Methoden bei der Untersuchung und Lösung von Problemen an, gegebenenfalls unter Rückgriff auf andere Disziplinen
- erkennen die Grenzen des heutigen Wissenstands und der heutigen Technik und tragen zur weiteren wissenschaftlichen und technologischen Entwicklung der Informatik bei
- diskutieren aktuelle Entwicklungen der Informatik und beurteilen deren Bedeutung

Methodenkompetenzen
Die Studierenden:
- evaluieren Werkzeuge, Technologien und Methoden und wenden diese differenziert an
- entwickeln kreativ neue und originäre Vorgehensweisen und Methoden
- reflektieren Probleme auch in neuen oder erst im Entstehen begriffenen Bereichen ihrer Disziplin und wenden Informatik-Methoden zur Untersuchung und Lösung an

Sozialkompetenzen
Die Studierenden:
- integrieren ihre Fähigkeiten in Teamprozesse

Selbstkompetenzen
Die Studierenden:
- verfolgen die weitere Entwicklung in der Informatik allgemein und in ihrem Spezialgebiet kritisch führen innovative Tätigkeiten in ihrem Berufsfeld erfolgreich und eigenverantwortlich aus

Module contents:
je nach Vertiefungsgebiet und zugeordneter Lehrveranstaltung

Recommended reading:
je nach Vertiefungsgebiet und zugeordneter Lehrveranstaltung

Links:

Language of instruction: English
Duration (semesters): 1 Semester
Module frequency: semi-annual
Module capacity: unlimited
Module level: unlimited

Type of module:
Teaching/Learning method: 2 events from V, S, Ü, P, PR
Previous knowledge: none
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**inf592 - Special Topics in 'Applied Artificial Intelligence' II**

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<tr>
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<td>Workload</td>
<td>180 h</td>
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</tbody>
</table>

**Applicability of the module**
- Master's Programme Computing Science (Master) > Angewandte Informatik

**Responsible persons**
- Sonntag, Daniel (module responsibility)
- Lehrenden, Die im Modul (authorised to take exams)

**Prerequisites**
- No participant requirement

**Skills to be acquired in this module**
The module aims to integrate current developments in the specialization area 'Learning and Cognitive Systems II' into the appropriate course formats within the study program.

**Professional competences**
The students:
- differentiate and contrast a specific area of computer science in which they have specialized, in more detail, or reflect on computer science in general
- recognize and assess the techniques and methods applicable in their specialized field and their limitations
- identify, structure and solve problems also in new or emerging areas of their discipline
- apply state-of-the-art and innovative methods in investigating and solving problems, possibly drawing from other disciplines
- recognize the limits of current knowledge and technology and contribute to the further scientific and technological development of computer science
- discuss current developments in computer science and assess their significance

**Methodological competencies**
The students:
- valuate tools, technologies, and methods and apply them in a differentiated manner, creatively developing new and original approaches and methods
- reflect on problems, even in emerging areas of their discipline, and apply computer science methods to investigate and solve them

**Social Competencies**
The students:
- integrate their skills into team processes

**Self-competences**
The students:
- critically follow the further developments in computer science in general and in their specialized area
- successfully and independently carry out innovative activities in their professional field

**Module contents**
This module offers various classes in the field of Learning and Cognitive Systems. For details regarding objectives and content, please refer to the specific class or contact the instructor directly.

**Recommended reading**
Depending on the area of specialization and the assigned course

**Language of instruction**
English

**Duration (semesters)**
1 Semester

**Module frequency**
irregular

**Module capacity**
unlimited

**Module level**

**Type of module**
<table>
<thead>
<tr>
<th>Teaching/Learning method</th>
<th>2 events from V, S, Ü, P, PR</th>
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<tbody>
<tr>
<td>Previous knowledge</td>
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<table>
<thead>
<tr>
<th>Examination</th>
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<th>Type of examination</th>
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<tbody>
<tr>
<td>Final exam of module</td>
<td>At the end of the lecture period by arrangement with the lecturer</td>
<td>Semester-long practical exercises or presentation or oral examination</td>
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<table>
<thead>
<tr>
<th>Type of course</th>
<th>VA-Auswahl</th>
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| SWS | 2 |
| Frequency | SoSe oder WiSe |
| On-site workload | 28 h |
inf492 - Special Topics in Theoretical Computer Science I

<table>
<thead>
<tr>
<th>Module label</th>
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<tr>
<td>Module abbreviation</td>
<td>inf492</td>
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<tr>
<td>Credit points</td>
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<td>Workload</td>
<td>180 h</td>
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<td>Applicability of the module</td>
<td>• Master's Programme Computing Science (Master) &gt; Theoretische Informatik</td>
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<tr>
<td>Responsible persons</td>
<td>• Wehrheim, Heike (module responsibility)</td>
</tr>
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<td></td>
<td>• Lehrenden, Die im Modul (authorised to take exams)</td>
</tr>
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<td>Prerequisites</td>
<td>No participant requirements</td>
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Skills to be acquired in this module

The module aims to integrate current developments in the specialization area "Modeling and Analysis of Complex Systems" I into the course of study in the appropriate course forms.

**Professional competencies**
The students

- differentiate and contrast a subarea of computer science in which they have specialized in more detail or reflect on computer science in general
- recognize and evaluate the techniques and methods to be applied in their special field and their limitations
- identify, structure and solve problems also in new or emerging areas of their discipline
- apply state-of-the-art and innovative methods in investigating and solving problems, drawing on other disciplines as appropriate
- recognize the limits of current knowledge and technology and contribute to the further scientific and technological development of computer science
- discuss current developments in computer science and assess their significance

**Methodological competencies**
The students

- evaluate tools, technologies and methods and apply them in a differentiated manner
- creatively develop new and original approaches and methods
- reflect on problems also in new or emerging areas of their discipline and apply computer science methods for investigation and solution

**Social Competencies**
The students

- integrate their skills into team processes

**Self-competencies**
The students

- critically follow further developments in computer science in general and in their field of specialization
- carry out innovative activities in their professional field successfully and independently

<table>
<thead>
<tr>
<th>Module contents</th>
<th>depending on the area of specialization and the assigned course</th>
</tr>
</thead>
<tbody>
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<td>Duration (semesters)</td>
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<td>Type of module</td>
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<td>Teaching/Learning method</td>
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</tr>
<tr>
<td>Previous knowledge</td>
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</tr>
<tr>
<td>Examination</td>
<td>Examination times</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>---------------------------</td>
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<tr>
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<td>at the end of the lecture term</td>
</tr>
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<td>Type of course</td>
<td>VA-Auswahl</td>
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<td>SWS</td>
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<tr>
<td>Frequency</td>
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### inf189 - Special Topics in Practical Computer Science I

<table>
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<tr>
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<tr>
<td>Module abbreviation</td>
<td>inf189</td>
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<tr>
<td>Credit points</td>
<td>6.0 KP</td>
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<tr>
<td>Workload</td>
<td>180 h</td>
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<tr>
<td>Applicability of the module</td>
<td>• Master's Programme Computing Science (Master) &gt; Praktische Informatik</td>
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</table>
| Responsible persons | • Peter, Andreas (module responsibility)  
• Vogel-Sonnenschein, Ute (module responsibility)  
• Lehrenden, Die im Modul (authorised to take exams) |
| Prerequisites | The required prerequisites are further specified in the details of the assigned course. |
| Skills to be acquired in this module | The module aims to integrate current developments in the field of Practical Informatics into the course of study in the appropriate course forms. |

#### Professional competences
The students:

- differentiate and contrast a subarea of practical computer science in more detail
- recognize and assess the techniques and methods to be applied in the special field of the course and their limits
- identify, structure and solve problems also in new or emerging areas of their discipline
- recognize the limits of current knowledge and technology and contribute to the further scientific and technological development of computer science
- discuss current developments in practical computer science and assess their significance
- critically follow further developments in the special field discussed in the course.

#### Methodological competences
Students will:

- apply state-of-the-art and innovative methods in the research and solution of problems, drawing on other disciplines where appropriate
- investigate problems on the basis of technical and scientific literature, write an article according to scientific criteria, and present their results in a scientific talk
- reflect on problems, including those in new or emerging areas of practical computer science, and apply computer science methods to investigate and solve them
- plan time schedules and other resources
- develop and reflect on their own theories on independently generated hypotheses

#### Social competences
Students will:

- communicate persuasively orally and in writing with users and professionals
- solve tasks goal-oriented in a team

#### Self competences
The students

- deepen their self-organization skills
- reflect self-critically on their actions and skills in the special field under consideration and assess them appropriately

#### Module contents
In this module, content and methods on current topics in practical computer science are taught.

For details on objectives and contents, please refer to the details of the assigned course or contact the lecturers directly

#### Recommended reading
depending on the course assigned

#### Links
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<tr>
<td><strong>Module capacity</strong></td>
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<tr>
<td><strong>Reference text</strong></td>
<td>see course description for more details</td>
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<td><strong>Module level</strong></td>
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<td><strong>Type of module</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Teaching/Learning method</strong></td>
<td>2 events from V, S, Ü, P</td>
</tr>
<tr>
<td><strong>Previous knowledge</strong></td>
<td>The required prerequisites are further specified in the details of the assigned course.</td>
</tr>
<tr>
<td><strong>Examination</strong></td>
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<tr>
<td>Examination</td>
<td>Examination times</td>
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<td><strong>Frequency</strong></td>
<td>SoSe oder WiSe</td>
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inf593 - Special Topics in 'Applied Artificial Intelligence' I

<table>
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<tr>
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<td>inf593</td>
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<tr>
<td>Credit points</td>
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<td>Applicability of the module</td>
<td>Master's Programme Computing Science (Master) &gt; Angewandte Informatik</td>
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<tr>
<td>Responsible persons</td>
<td>Sonntag, Daniel (module responsibility)</td>
</tr>
<tr>
<td></td>
<td>Lehrenden, Die im Modul (Module counselling)</td>
</tr>
<tr>
<td>Prerequisites</td>
<td>No participant requirement</td>
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</table>

Skills to be acquired in this module

This module aims to integrate current developments in the specialization area "Learning and Cognitive Systems" I into the course of study in the appropriate course forms.

Professional competences
The students:

- differentiate and contrast a specific area of computer science in which they have specialized, in more detail, or reflect on computer science in general
- recognize and assess the techniques and methods applicable in their specialized field and their limitations
- identify, structure and solve problems also in new or emerging areas of their discipline
- apply state-of-the-art and innovative methods in investigating and solving problems, possibly drawing from other disciplines
- recognize the limits of current knowledge and technology and contribute to the further scientific and technological development of computer science
- discuss current developments in computer science and assess their significance

Methodological competencies
The students:

- valuate tools, technologies, and methods and apply them in a differentiated manner, creatively developing new and original approaches and methods
- reflect on problems, even in emerging areas of their discipline, and apply computer science methods to investigate and solve them

Social Competencies
The students:

- integrate their skills into team processes

Self-competences
The students:

- critically follow the further developments in computer science in general and in their specialized area
- successfully and independently carry out innovative activities in their professional field

Module contents
depending on the area of specialization and the assigned course

Recommended reading
depending on the area of specialization and the assigned course

Language of instruction
English

Duration (semesters)
1 Semester

Module frequency
irregular

Module capacity
unlimited

Module level

Type of module
1VL + 1Ü

Previous knowledge
none
<table>
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<tr>
<th>Examination</th>
<th>Examination times</th>
<th>Type of examination</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Final exam of module</strong></td>
<td>At the end of the lecture period by arrangement with the lecturer.</td>
<td>Practical exercises and presentation or oral examination</td>
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<table>
<thead>
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<th>Comment</th>
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<th>Frequency</th>
<th>Workload of compulsory attendance</th>
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<tr>
<td>Lecture</td>
<td></td>
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<td>SoSe oder WiSe</td>
<td>28</td>
</tr>
<tr>
<td>Exercises</td>
<td></td>
<td>2</td>
<td>SoSe oder WiSe</td>
<td>28</td>
</tr>
<tr>
<td><strong>Total module attendance time</strong></td>
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<td></td>
<td></td>
<td>56 h</td>
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**inf581 - Special Topics in 'Digitalised Energy Systems' II**

<table>
<thead>
<tr>
<th><strong>Module label</strong></th>
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</tr>
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<tbody>
<tr>
<td><strong>Module abbreviation</strong></td>
<td>inf581</td>
</tr>
<tr>
<td><strong>Credit points</strong></td>
<td>6.0 KP</td>
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<tr>
<td><strong>Workload</strong></td>
<td>180 h</td>
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</table>
| **Applicability of the module** | - Master's Programme Computing Science (Master) > Angewandte Informatik  
- Master's programme Digitalised Energy Systems (Master) > Digitalised Energy System Automation, Control and Optimisation |
| **Responsible persons** | - Nieße, Astrid (module responsibility)  
- Lehrenden, Die im Modul (authorised to take exams) |
| **Prerequisites** | No participant requirements |
| **Skills to be acquired in this module** | This module integrates current developments in the field of Digitalised Energy Systems in adequate study courses.  
**Professional competences**  
The students:  
- define and contrast a computer science part, in which they are specialised, in detail or  
- evaluate computer science in general  
- recognise and evaluate applied techniques and methods of their subject and are aware of their limits  
- identify, structure and solve problems/tasks, also in new or developing subject areas  
- apply state of the art and innovative methods to solve problems, if necessary from other disciplines  
- are aware of the current limits and contribute to the development of computer science research and technology  
- discuss and evaluate recent computer science developments  
**Methodological competences**  
The Students:  
- evaluate tools, technologies and methods  
- sophisticatedly combine new and original approaches and methods  
- creatively evaluate problems/tasks, including new or developing subject areas of their discipline  
- apply computer science methods for solutions and research  
**Social competences**  
The Students:  
- support team process by their abilities  
**Self-competences**  
The Students:  
- pursue the overall and special computer science development  
- critically implement innovative professional activities effectively and independently |
<p>| <strong>Module contents</strong> | See assigned course description |
| <strong>Recommended reading</strong> | Will be announced in the course |
| <strong>Language of instruction</strong> | English |
| <strong>Duration (semesters)</strong> | 1 Semester |
| <strong>Module frequency</strong> | irregular |
| <strong>Module capacity</strong> | unlimited |
| <strong>Module level</strong> | |
| <strong>Type of module</strong> | |
| <strong>Teaching/Learning method</strong> | 2 events from VL, Ü, S, PR |
| <strong>Previous knowledge</strong> | none |
| <strong>Examination</strong> | Examination times |
| <strong>Type of examination</strong> | Portfolio or presentation or oral examination |
| <strong>Final exam of module</strong> | At the end of the lecture period |</p>
<table>
<thead>
<tr>
<th>Type of course</th>
<th>Comment</th>
<th>SWS</th>
<th>Frequency</th>
<th>Workload of compulsory attendance</th>
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<tbody>
<tr>
<td>Lecture</td>
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<td>SoSe oder WiSe</td>
<td>28</td>
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<tr>
<td>Exercises</td>
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<td>2</td>
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<td>28</td>
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<tr>
<td><strong>Total module attendance time</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>56 h</strong></td>
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</table>