Fundamentals/Foundations

inf960 - Fundamental Competences in Computing Science I: Signals and Dynamical Systems

Module label
Fundamental Competences in Computing Science I: Signals and Dynamical Systems

Module code
inf960

Credit points
6.0 KP

Workload
180 h

Used in course of study
- Master's Programme Engineering of Socio-Technical Systems (Master) > Fundamentals/Foundations

Contact person
Module responsibility
- Martin Georg Fränzle
- Andreas Hein

Authorized examiners
- Die im Modul Lehrenden

Entry requirements

Skills to be acquired in this module
This course provides an introduction into digital signal processing. It covers the mathematical foundations necessary for understanding the impact digitization has on a continuous signal as well as the goal-directed synthesis of digital filters. As such, it lays the theoretical foundations preparing for understanding and designing applications of digital signal processing in a variety of fields relevant to the MSc EngSTS, like neurophysiological measurements, brain-computing interfaces, or embedded control. In contrast to subsequent modules of the study programme, the module itself does not aim at covering such applications, but at providing a solid grasp of the underlying principles and the fundamental constraints to digital signal processing. It is targeted at psychologists, but also at computer scientists who have not previously been exposed to a systematic mathematical treatment of the fundamentals of digital signal processing.

Professional competences:
The students:
- Name the concepts of signal and image processing in technical systems
- Name the methods/algorithms of preprocessing, filtering, classification, interpretation and visualisation of signals and pictures
- Select algorithms appropriately
- Evaluate the effectiveness of algorithms
- Design algorithms and processing chains and evaluate their quality

Methodological competences:
The students:
- Get used to specific subjects of signal and image processing

Social competences:
The students:
- Present solutions for specific questions in signal and image processing

Self-competences:
The students:
- Reflect their solutions by using methods learned in this course

Module contents
- Basic Concepts
- Signal Processing
- Signal Spaces and Signal Processing Systems
- Discrete and Constant Signals
- Labelling of Signal Transmitters with Test Signals
- Representations Areas and Transformations
- Time-Discrete Systems and Scanning
- Estimation and Filtering
- Construction with MATLAB
- Image Processing
- Introduction / Range of Applications
- Functional Transformation
- Image Enhancement/Filtering
- Segmentation
- 3D Reconstruction an Visualization

Reader's advisory

essential: Slides

recommended:
-Meyer, M.; Signalverarbeitung: Analoge und digitale Signale, Systeme und Filter
-Grünningen, D. C. v.; Digitale Signalverarbeitung: mit einer Einführung in die kontinuierlichen Signale und Systeme
-Tönnies, K.; Grundlagen der Bildverarbeitung; Pearson Studium 2005
-Lehmann, Th.; Oberschelp, W.; Pelinak, E.; Pepges, R.; Bildverarbeitung in der Medizin; Springer Verlag 1997
-Handels, H.; Medizinische Bildverarbeitung; Teubner Verlag, Stuttgart - Leipzig 2000

Language of instruction

English

Duration (semesters)

1 Semester

Module frequency

Once a year

Module capacity

unlimited

Reference text

This course is part of the base curriculum of the MSc program "Engineering of Socio-Technical Systems". It provides students featuring a background in psychology with fundamental competences in computer science and related subjects. This course is also intended for students with a background in computer science lacking prior knowledge in digital signal processing

Module level

BC (Basiscurriculum / Base curriculum)

Modular

Pflicht o. Wahlpflicht / compulsory or optional

Lern-/Lehrform / Type of program

V+Ü

Vorkenntnisse / Previous knowledge

Modul math040 Analysis II b: Differentialgleichung mehrerer Variablen

Examination

Time of examination

Type of examination

Final exam of module

At the end of the lecture period

Hands-on exercises and written or oral exam

Course type

Comment

SWS

Frequency

Workload attendance

Lecture

2.00

WiSe

28 h

Exercises

2.00

WiSe

28 h

Total time of attendance for the module

56 h
# inf961 - Fundamental Competences in Computing Science II: Mathematics

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<th>Fundamental Competences in Computing Science II: Mathematics</th>
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<tr>
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<td>◦ Heinz-Georg Quebbemann</td>
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<td>◦ Florian Heß</td>
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<td>◦ Andreas Stein</td>
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<td>◦ Martin Georg Fränzle</td>
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<td>◦ Die im Modul Lehrenden</td>
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**Entry requirements**

**Skills to be acquired in this module**
The courses provide an introduction to the fundamental methods of mathematical formalisation and proof, as well as to the central concepts of graph theory, elementary number theory, and algebra. The selection of topics is based on their particular relevance to computer science and related disciplines. Within the curriculum of the MSc EngSTS, this course provides students featuring a BSc in psychology or related subjects with the skills in mathematical formalization that are necessary for mastering subsequent courses in computer science.

**Professional competences:**
The students get acquainted with the formalisms and reasoning underlying modern mathematics, and they are able to apply these to concrete problems. They understand the central concepts and methods of graph theory, elementary number theory, and algebra relevant to computer science and related disciplines

**Methodological competences:**
The students are able to apply fundamental methods of mathematical formalisation and reasoning to concrete problems. They are able to retrieve the verdicts originating from such formal reasoning and to interpret them in terms of the original, informal problem description. students:

**Social competences:**
The students are able to explain mathematical formalizations to each other and to discuss their justification

**Self-competences:**
The students are able to reflect appropriateness of their formalisation and verification attempts

**Module contents**
Propositional logic; methods of mathematical proof; sets, relations, and functions; combinatorics; graphs and their applications; natural and integer numbers and their residue classes; groups and sime-groups.

The module consists of a lecture and an exercise part.

**Reader's advisory**
B. Kreußler und G. Pfister: Mathematik für Informatiker, Springer-Verlag 2009 (available online from the university library)

**Links**

**Language of instruction**
English

**Duration (semesters)**
1 Semester

**Module frequency**
compulsory

**Module capacity**
unlimited

**Reference text**
This course is part of the base curriculum of the MSc program "Engineering of Socio-Technical Systems". It provides students featuring a background in psychology with the fundamental competences in mathematical formalization that are necessary for mastering subsequent courses in computer science. This course is not intended for students with a background in computer science.

**Modullevel**
BC (Basiscurriculum / Base curriculum)

**Modulart**
Pflicht o. Wahlpflicht / compulsory or optional

**Lern-/Lehrform / Type of program**
V+Ü

**Vorkenntnisse / Previous knowledge**

**Examination**

**Time of examination**

**Type of examination**

**Final exam of module**
At the end of the lecture periods
written exam or oral exam

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**Module label**
Fundamental Competences in Computing Science III: Algorithms and Computational Problem Solving

**Module code**
inf962

**Credit points**
6.0 KP

**Workload**
180 h

**Used in course of study**
- Master's Programme Engineering of Socio-Technical Systems (Master) > Fundamentals/Foundations

**Contact person**
Module responsibility
- Lehrende der Informatik

Authorized examiners
- Die im Modul Lehrenden

**Entry requirements**

**Skills to be acquired in this module**
The students acquire a thorough understanding of the fundamental methods of computer science in general and the use of algorithms for computational problem solving in particular. They learn how structure problems, model problems and solutions, and develop and implement computational solutions. Within the curriculum of the MSc EngSTS, this course provides students featuring a BSc in psychology or related subjects with fundamental skills in computational problem solving that are necessary for mastering subsequent courses in computer science.

**Professional competences:**
The students understand concepts for representing information computationally, they know pertinent data structures and algorithms and can argue about their complexity, and they are acquainted with formal concepts like automata and formal languages as a means of modeling

**Methodological competences:**
The students are able to analyze problems from their application domain, to conceive computational solutions, and to estimate the effort involved in their realization and execution. They are able to evaluate alternative computational representations of data and problems and to draw informed conclusions for subsequent decisions in design and implementation

**Social competences:**
The students:
The students are able to present and discuss their solutions in an interdisciplinary team

**Self-competences:**
The students are able to critically reflect fundamental design decisions in algorithms and data structures

**Module contents**
Computer representation of information; formal languages, grammar and automata; basic data structures; algorithms and complexity; programming in the small

**Reader’s advisory**

**Links**

**Language of instruction**
English

**Duration (semesters)**
1 Semester

**Module frequency**
one a year

**Module capacity**
unlimited

**Reference text**
This course is part of the base curriculum of the MSc program "Engineering of Socio-Technical Systems". It provides students featuring a background in psychology with skills in computational problem solving as necessary for mastering subsequent courses in computer science. This course is not intended for students with a background in computer science

**Modullevel**
BC (Basiscurriculum / Base curriculum)

**Modulart**
Pflicht o. Wahlpflicht / compulsory or optional

**Lern-/Lehrform / Type of program**
V+Ü

**Vorkenntnisse / Previous knowledge**

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**Total time of attendance for the module**
56 h
**inf963 - Foundations of STS Eng.: Cognitive Processes**

**Module label**
Foundations of STS Eng.: Cognitive Processes

**Module code**
inf963

**Credit points**
6.0 KP

**Workload**
180 h

**Used in course of study**
- Master's Programme Engineering of Socio-Technical Systems (Master) > Fundamentals/Foundations

**Contact person**
Module responsibility
- Martin Georg Fränzle
- Die im Modul Lehrenden

Authorized examiners
- Die im Modul Lehrenden

**Entry requirements**

**Skills to be acquired in this module**
The module aims to provide an overview of theories of cognitive processes.

Part 1 will be a lecture on neurocognition. Students will first acquire a general understanding of the brain mechanisms of different cognitive functions and the methods used to study these functions:

- Brain and cognition, methods of cognitive neuroscience
- Attention, learning and memory
- Emotional and social behavior
- Language, executive functions

Part 2 will be a lecture on neurophysiology. Students will acquire specific knowledge about neurophysiology and neuroanatomy, learn the fundamental concepts of multi-channel EEG analysis, and acquire hands-on skills in using EEGLAB, an open-source software toolbox for advanced EEG analysis.

**Competencies:**
- Understanding of basic concepts of biomedical signal processing; using EEG analysis tools interactively and independently; understanding the complete chain of EEG analysis steps, from data import to the illustration of results; ability to use open source tools for EEG analysis; application of theoretical knowledge to practical problems of physiology.

Part 3 will be a seminar on cognitive engineering. Students will be introduced to methods, tools, and techniques (MTTs) to evaluate and predict human performance in small use cases in different domains (Aviation, Air Traffic Control, Automotive, Maritime, or Healthcare). Each student is expected to study and apply the MTT based on material and software provided and present and discuss the modeling approach and the results achieved with the other participants and experts in the seminar.

**Professional competences:**
- Neuropsychological / neurophysiological knowledge

**Methodological competences:**
- interdisciplinary knowledge & thinking

**Social competences:**
- Written and oral presentation and discussion of scientific and technical results with others.

**Self-competences:**
- Reading, understanding, summarizing and critically evaluating scientific texts/literature

**Module contents**

**Part 1 neurocognition:**

**Part 2 neurophysiology:**
Part 3 cognitive engineering:
Paternò, F (2000). Model-Based Design and Evaluation of Interactive Applications
Wickens & Hollands (2012). Engineering Psychology & Human Performance

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inf964 - Foundations of STS Eng.: Psychology and Philosophy of Technology

Module label: Foundations of STS Eng.: Psychology and Philosophy of Technology

Module code: inf964

Credit points: 6.0 KP

Workload: 180 h

Used in course of study: Master's Programme Engineering of Socio-Technical Systems (Master) > Fundamentals/Foundations

Contact person:

Module responsibility:
- Rainer Röhrig

Authorized examiners:
- Die im Modul Lehrenden

Entry requirements:

Skills to be acquired in this module:

The module aims to provide an overview of theories of (Neuro)Cognitive Psychology with potential for application, concepts for technology assessments and ethical principals and their applicability for the field of (Neuro)Cognitive Psychology. In addition to these learning aims, they will experience chances and limitations of technology assessments. Thus, it will cover core concepts of cognitive psychology, their neuronal basis, basic knowledge of neuroimaging and data analysis techniques. Special emphasis will be put on research aiming at complex real-world settings and translation of basic science into practice. Examples of successful transfers will be analyzed. Parts 1 (lecture) and 2 (seminar) will run in parallel. The lecture provides the theoretical basis. In the seminar the material is consolidated by examples from the literature will be presented and critically analyzed and discussed.

Professional competences:
The students:

- Should have a repertoire of cognitive psychology concepts relevant for real world situations
- Should be able to familiarize themselves with important ethical concepts, are able to explain them, and transmit them on scenarios of the technology assessment
- Should know and be able to explain different forms and concepts of technology assessments (Expert, participatory, constructive, discursive Technology Assessment, Health Technology Assessment (HTA))
- Should be able to reflect the collingridge dilemma

Methodological competences:
The students:

- Should be able to transfer the learned theoretical concepts into practical contexts
- Should be able to perform a systematic literature review
- Should be able to evaluate potential issues arising in the process of translation
- Should be able to do a risk-benefit analysis and cost-benefit analysis of given examples
- Should know and can explain empirical methods for technology assessment
- Methodological considerations: Generalization, validity of theories and research methods

Social competences:
The students:

- Should be able to argue on different point of views based on different

Self-competences:
The students:

- Should be able to reflect their own attitudes and able to explain them using ethical principles
- Pursuing goals: Thinking, problem solving and acting

Module contents:
The module consists of a lecture and an seminar part:

Lecture:

- Neurocognitive Psychology with emphasis in real world context
- Ethical Principals an Concepts
- Forms and Concepts of Technology Assessment
- Chances and Limitations of Technology Assessment

General: Presentation as well as critical evaluation and discussion of scientific literature, application of
research methods, transfer of scientific paradigms (concepts and methods) to real-world situations.

Seminar: The students write a thesis for a given technological innovation. In this, various concepts of ethical assessment and technology assessment are to be applied. The innovation is to be discussed critically from different perspectives. Advantages against disadvantages, benefits against damage, opportunities against dangers, self-interest against common public interest are to be weighed.

Reader’s advisory


Links

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<td>The module will be offered in summer terms and should be completed within one semester. Both parts will run in parallel.</td>
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Vorkenntnisse / Previous knowledge

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Total time of attendance for the module 56 h
inf965 - Foundations of STS Eng.: Systems Engineering

<table>
<thead>
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<td>Workload</td>
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- Master's Programme Engineering of Socio-Technical Systems (Master) > Fundamentals/Foundations

### Contact person

- Module responsibility
  - Axel Hahn
  - Martin Georg Fränzle
- Authorized examiners
  - Die im Modul Lehrenden

### Entry requirements

**Professional competences:**
Designing and maintaining complex artefacts are a major challenge of engineering for decades. System Engineering is an approach to handle this complexity. By completing this module, the students are aware of the challenges of complexity. They know how systems engineering can address these while designing complex but reliable, dependable and safe products. A major corner stone is to know the concept of a system and to describe it using appropriate modelling techniques. The student starts thinking in systems as an aggregation of components that may again be a component of an aggregated system up to the concepts of systems of systems. They are able to understand the effects of single components attributes on the system as a whole including humans as elements of complex systems.

**Methodological competences:**
The students are able to apply system-engineering methodologies and methods to understand requirements, to design, implement and test systems.

**Professional competences:**
Usage of engineering tools will provide practical experience.

**Social competences:**
They are aware of the role complex systems play in our society and got an understanding of complexity management as a self-competence in engineering.

### Module contents

The module consists of a lecture and an exercise part:

**Lecture:** Introduction to the concepts of systems, methodologies and methods of systems engineering. As special emphasis is put on the usage of SYSML as a modelling approach.

**Exercises:** Own design experiences by using engineering methods and tools.

### Reader's advisory


### Links

- **Language of instruction:** English
- **Duration (semesters):** 2 Semester
- **Module frequency:** each term
- **Module capacity:** unlimited
- **Module level:** BC (Basics curriculum / Base curriculum)
- **Moduleart:** Pflicht o. Wahlpflicht / compulsory or optional
- **Lern-/Lehrform / Type of program:** V+Ü

### Examination

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<th>Examination</th>
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**Total time of attendance for the module:** 56 h

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inf966 - Foundations of STS Eng.: Statistics and Programming

Module label: Foundations of STS Eng.: Statistics and Programming
Module code: inf966
Credit points: 6.0 KP
Workload: 180 h
Used in course of study: Master's Programme Engineering of Socio-Technical Systems (Master) > Fundamentals/Foundations

Contact person
Module responsibility
- Antje Timmer
- Andreas Hein
Authorized examiners
- Die im Modul Lehrenden

Entry requirements

Skills to be acquired in this module
Professional competences:
The students learn:
To plan, program and interpret statistical data evaluation via programming.

Methodological competences:
The students:
- understand the main statistical methods and their practical use through application
- can evaluate statistical methods regarding the qualities and their limits
- learn the use of statistical software in application scenarios
- can implement programs via a programming language
- know how to program statistical data analyses

Social competences:
The students gain experience in interdisciplinary work.

Self-competences:
The students gain experiences in
- Pursuing goals: Thinking, problem solving and acting
- Ability to analyze and evaluate the effects and relevance of datasets for specific research questions

Module contents
The module consists of a lecture and an exercise part:
Lecture: Introduction to the concepts and methods for computer supported statistically data evaluation. Special emphasis is put on statistically methodical as well as on a basic understanding of programming languages.
1. Fundamental Computer Science Concepts in regard to the handling of imperative programming languages including:
   - variable types and variable handling
   - typical code structures (such as "while / for loops" or "if-then else" statements)
   - data-handling and computation approaches
2. Fundamental static methodology such as:
   - estimating parameters through the method of maximum likelihood
   - confidence intervals and classical significance testing
   - classical regression analysis
   - modern advancements in regression analysis

Exercises: Stepwise practical or paper based use of the learned concepts, methods and tools.

Reader's advisory

Links

Language of instruction: English
Duration (semesters): 1 Semester
Module frequency: Once a year
Module capacity: unlimited
Modullevel: BC (Basiscurriculum / Base curriculum)
### Modulart
Pflicht o. Wahlpflicht / compulsory or optional

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### Vorkenntnisse / Previous knowledge

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Total time of attendance for the module **56 h**
inf970 - Fundamental Competences in Psychology I: Psychology

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<td>inf970</td>
</tr>
<tr>
<td>Credit points</td>
<td>6.0 KP</td>
</tr>
<tr>
<td>Workload</td>
<td>180 h</td>
</tr>
<tr>
<td>Used in course of study</td>
<td>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Fundamentals/Foundations</td>
</tr>
<tr>
<td>Contact person</td>
<td></td>
</tr>
<tr>
<td>Module responsibility</td>
<td></td>
</tr>
<tr>
<td>• Christoph Siegfried Herrmann</td>
<td></td>
</tr>
<tr>
<td>• Die im Modul Lehrenden</td>
<td></td>
</tr>
<tr>
<td>Authorized examiners</td>
<td></td>
</tr>
<tr>
<td>• Die im Modul Lehrenden</td>
<td></td>
</tr>
<tr>
<td>Entry requirements</td>
<td></td>
</tr>
<tr>
<td>Skills to be acquired in this module</td>
<td>The lecture will be based mainly on the textbook by Atkinson &amp; Hilgards. It will introduce the students to selected topics of Experimental Psychology which are relevant for socio-technical systems (e.g. learning &amp; memory, perception, language, emotion). It will also cover aspects of Social Psychology, Psychological Disorders, and Individual Psychology. It thereby provides students with a background in computer science or a related discipline with fundamental skills in experimental psychology necessary for mastering the subsequent courses from psychology featured in the curriculum.</td>
</tr>
<tr>
<td>Professional competence</td>
<td>The students:</td>
</tr>
<tr>
<td>• will acquire basic knowledge in selected topics of Psychology</td>
<td></td>
</tr>
<tr>
<td>Methodological competence</td>
<td>The students:</td>
</tr>
<tr>
<td>• learn selected methods and theories of Psychology</td>
<td></td>
</tr>
<tr>
<td>Social competence</td>
<td>The students:</td>
</tr>
<tr>
<td>• will learn to work together in small groups</td>
<td></td>
</tr>
<tr>
<td>• will communicate scientific theories</td>
<td></td>
</tr>
<tr>
<td>Self-competences</td>
<td>The students:</td>
</tr>
<tr>
<td>• will learn to apply their knowledge in other, more specific Psychology courses</td>
<td></td>
</tr>
<tr>
<td>Module contents</td>
<td></td>
</tr>
<tr>
<td>Links</td>
<td></td>
</tr>
<tr>
<td>Language of instruction</td>
<td>English</td>
</tr>
<tr>
<td>Duration (semesters)</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Module frequency</td>
<td>once a year</td>
</tr>
<tr>
<td>Module capacity</td>
<td>unlimited</td>
</tr>
<tr>
<td>Reference text</td>
<td>This course is part of the base curriculum of the MSc program &quot;Engineering of Socio-Technical Systems&quot;. It provides students featuring a background in computer science with fundamental competences in experimental psychology as necessary for mastering the courses from psychology subsequently featured in the curriculum. This course is not intended for students with a background in psychology.</td>
</tr>
<tr>
<td>Modullevel</td>
<td>BC (Basiscurriculum / Base curriculum)</td>
</tr>
<tr>
<td>Modulart</td>
<td>Pflicht o. Wahlpflicht / compulsory or optioal</td>
</tr>
<tr>
<td>Lern-/Lehrform / Type of program</td>
<td>V+Ü</td>
</tr>
<tr>
<td>Vorkenntnisse / Previous knowledge</td>
<td></td>
</tr>
<tr>
<td>Examination</td>
<td>Time of examination</td>
</tr>
<tr>
<td>Examination</td>
<td>Type of examination</td>
</tr>
<tr>
<td>Examination</td>
<td>Time of examination</td>
</tr>
<tr>
<td>---------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td><strong>Final exam of module</strong></td>
<td>During the last lecture appointment</td>
</tr>
<tr>
<td><strong>Course type</strong></td>
<td><strong>Comment</strong></td>
</tr>
<tr>
<td>Lecture</td>
<td></td>
</tr>
<tr>
<td>Exercises</td>
<td></td>
</tr>
</tbody>
</table>

**Total time of attendance for the module** 56 h
inf971 - Fundamental Competences in Psychology II: Introduction to Neuroscience

<table>
<thead>
<tr>
<th>Module label</th>
<th>Fundamental Competences in Psychology II: Introduction to Neuroscience</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module code</td>
<td>inf971</td>
</tr>
<tr>
<td>Credit points</td>
<td>6.0 KP</td>
</tr>
<tr>
<td>Workload</td>
<td>180 h</td>
</tr>
<tr>
<td>Used in course of study</td>
<td>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Fundamentals/Foundations</td>
</tr>
<tr>
<td>Contact person</td>
<td>Module responsibility</td>
</tr>
<tr>
<td></td>
<td>○ Christiane Margarete Thiel</td>
</tr>
<tr>
<td></td>
<td>Authorized examiners</td>
</tr>
<tr>
<td></td>
<td>○ Die im Modul Lehrenden</td>
</tr>
</tbody>
</table>

**Entry requirements**

**Skills to be acquired in this module**

This module provides students without any prior knowledge in biological psychology with basic knowledge on the neurobiology of sensory and cognitive functions which is especially relevant for later modules on brain-computer interfaces. It therefore provides an introduction to basic concepts of neurobiological foundations of sensory, motor and cognitive functions.

**Professional competences:**

The students will be able to understand basic concepts of neurobiological foundations of cognition and present these to fellow students of different backgrounds:

**Methodological competences:**

The students will learn to present and discuss scientific findings

**Social competences:**

The students will learn to interact in a group

**Self-competences:**

The students will be able to assess their own knowledge and understanding in the context of an interdisciplinary group

**Module contents**

The lecture includes the neuroanatomy of different sensory systems such as vision and audition, motor systems and higher cognitive functions. The seminar will focus on lecture topics based on the book chapters. These contents will be acquired in group work.

**Reader's advisory**


**Links**

Language of instruction: English

Duration (semesters): 1 Semester

Module frequency: once a year

Module capacity: unlimited

**Reference text**

This module provides students without any prior knowledge in biological psychology with basic knowledge on the neurobiology of sensory and cognitive functions which is especially relevant for later modules on brain-computer interfaces. The course provides students featuring a background in computer science with fundamental competences in psychology and related subjects. This course is not intended for students already featuring a background in psychology.

**Modullevel**

BC (Basiscurriculum / Base curriculum)

**Modulart**

Pflicht o. Wahlpflicht / compulsory or optional

**Lern-/Lehrform / Type of program**

V+S

**Vorkenntnisse / Previous knowledge**

**Final exam of module**

<table>
<thead>
<tr>
<th>Course type</th>
<th>Comment</th>
<th>Time of examination</th>
<th>Type of examination</th>
<th>SWS</th>
<th>Frequency</th>
<th>Workload attendance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td></td>
<td>March</td>
<td>Written exam</td>
<td>2.00</td>
<td>WiSe</td>
<td>28 h</td>
</tr>
<tr>
<td>Seminar</td>
<td></td>
<td></td>
<td></td>
<td>2.00</td>
<td>WiSe</td>
<td>28 h</td>
</tr>
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</table>

**Total time of attendance for the module**

56 h
inf972 - Fundamental Competences in Psychology III: Experiments and Studies

Module label: Fundamental Competences in Psychology III: Experiments and Studies

Module code: inf972

Credit points: 6.0 KP

Workload: 180 h

Used in course of study:
- Master's Programme Engineering of Socio-Technical Systems (Master) > Fundamentals/Foundations

Contact person:

Module responsibility
- Susanne Boll-Westermann

Authorized examiners
- Die im Modul Lehrenden

Entry requirements:
The module inf972 Fundamental Competences in Psychology III: Experiments and Studies forms a basic curriculum in the MSc Engineering Socio-Technical Systems for students with a degree in computer science to complement their scientific education in the field of designing, planning and carrying out scientific experiments and studies. The course focuses on methods for studying human machine interaction in socio-technical systems as they are addressed in this MSc degree.

The module introduces on standard methods of scientific experiments. The module is based on standard introductory text books in Psychology, as for example the standard text book "Das psychologische Experiment, Eine Einführung, Osswald Huber, 2005" (will be taught in English of course) or in the standard textbook in the field of Human Computer Interaction: Research Methods in HCI, Jonathan Lazar, Jinjuan Heidi Feng, Harry Hochheiser, John Wiley and Sons Ltd, 2009.

With this module, students with a background in Computer Science can complement their expertise in the field of scientific experiments and methods and provide them with a basis knowledge in this area. It will give them prerequisites to jointly attend courses and get practical assignments in later terms of their studies together with the students with a background in psychology for whom the methods and tools for scientific experiments are part of their BSc studies.

This module provides students without prior knowledge of designing, planning, and carrying out scientific experiments and studies with the basic knowledge in that field as relevant for mastering subsequent modules in the curriculum. The course is compulsory for students featuring a background in computer science and lacking fundamental competences in psychology. It is not intended for students already featuring a background in psychology.

Skills to be acquired in this module:

Professional competences:

Methodological competences:
The students are introduced into the design, implementation and also the analysis and interpretation of experiments.

Social competences:

Self-competences:
The students have knowledge of the tools and methods used for experiment design and evaluation. They are able to choose the right methods for their specific experiment. They are able to design and run experiments.

Module contents:

Content of the module:
Introduction into experimental psychology
- Variables, dependent and independent variables
- Formulating Hypotheses / Hypothesis testing
- Correlation and Cause
- Quantitative and qualitative methods
- Surveys, Experiments, Observational Studies

Experiment design / Study designs
- Between-Subjects Experiments
- Within-Subjects Experiments
- Randomized Control Trials
- Practical Considerations
- Complex Research Designs
- Single-Subject Research
- Lab studies vw. Studies in the wild
- Single factor vs. multifactor designs

Participants
- Recruiting participants
- Participants sampling
- Randomization
• Power Calculation

Tools
• SoSci Survey for online survey
• Statistic Tools

Analysis
• Descriptive Statistics
• Descriptive statistics and Correlation coefficients
• Statistical analysis of the data
• Internal and external validity

Ethics
• Institutional Review Boards
• Informed Consent

The module consists of a lecture and an exercise part:
Lecture: Theoretical introduction into the concepts and scientific methods of experiment design.
Exercises: Deepening the understanding of the experiments by planning and carrying out a survey and an experimental study in teams over the course of the term.

Reader's advisory

• Das psychologische Experiment, Eine Einführung, Osswald Huber, 2005
• How to Design and Report Experiments, Andy Field, sage 2003
• Research Methods in HCI, Jonathan Lazar, Jinjuan Heidi Feng, Harry Hochheiser, John Wiley and Sons Ltd, 2009
• Allgemeine Psychologie, Müßeler, Jochen, Berlin : Heidelberg: Springer, 2017

Links

Language of instruction English
Duration (semesters) 1 Semester
Module frequency once a year
Module capacity unlimited

Reference text
This module provides students without prior knowledge of designing, planning, and carrying out scientific experiments and studies with the basic knowledge in that field as relevant for mastering subsequent modules in the curriculum. The course is compulsory for students featuring a background in computer science and lacking fundamental competences in psychology. It is not intended for students already featuring a background in psychology.

Modullevel BC (Basiscurriculum / Base curriculum)
Modulart Pflicht o. Wahlpflicht / compulsory or optional

Lern-/Lehrform / Type of program

Vorkenntnisse / Previous knowledge

Examination Time of examination Type of examination

Final exam of module At the end of the lecture period practical work and oral exam

Course type Comment SWS Frequency Workload attendance
Lecture 2.00 WiSe 28 h
Exercises 2.00 WiSe 28 h

Total time of attendance for the module 56 h
Human-Computer Interaction

inf100 - Human Computer Interaction

<table>
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<tr>
<th>Module label</th>
<th>Human Computer Interaction</th>
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<tr>
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<td>inf100</td>
</tr>
<tr>
<td>Credit points</td>
<td>6.0 KP</td>
</tr>
<tr>
<td>Workload</td>
<td>180 h</td>
</tr>
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</table>

**Used in course of study**
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Praktische Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction

**Contact person**
- Module responsibility
  - Susanne Boll-Westermann
  - Die im Modul Lehrenden
- Authorized examiners
  - Susanne Boll-Westermann
  - Die im Modul Lehrenden

**Entry requirements**

**Skills to be acquired in this module**

**Professional competence**
- The students:
  - Name the human-computer interaction core principles
  - Characterise the basic elements of the human-centered design of interactive systems

**Methodological competence**
- The students:
  - Comprehend context of use and user requirements of human-machine interfaces
  - Design, develop and evaluate human-machine interfaces
  - Conduct experiments with their prototypes

**Social competence**
- The students:
  - Implement human-computer interfaces in practical hands-on projects in teams
  - Evaluate human-machine interfaces with potential users
  - Develop and present solutions for Human-Computer Interaction related problems
  - Integrate technical and factual comments into own results

**Module contents**
- The module introduces the field of human-computer interfaces and their historical context. Moreover, it shows motivating examples of human-computer interaction.
- The module covers the core principles of human-computer interaction. In detail, the module deals with the design concepts of interactive systems: context of use, requirements and task analysis, human perception capabilities, design process, usability, prototyping and evaluation. During the practical project a concrete human-computer interface will be designed, developed and evaluated according to these concepts.

**Reader's advisory**
- Markus Dahm, Grundlagen der Mensch Computer-Interaktion, Pearson, 2006
- Literature in the reserve shelf in the university bibliography. Link list in Stud.IP.

**Links**
- medien.informatik.uni-oldenburg.de/lehre

**Languages of instruction**
- German, English

**Duration (semesters)**
- 1 Semester

**Module frequency**
- once a year

**Module capacity**
- unlimited
<table>
<thead>
<tr>
<th>Module level</th>
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<tbody>
<tr>
<td>Modulart</td>
<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
</tr>
<tr>
<td>Lern-/Lehrform / Type of program</td>
<td>V+P</td>
</tr>
<tr>
<td>Vorkenntnisse / Previous knowledge</td>
<td>Grundkenntnisse Programmierung</td>
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**Examination**

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

<table>
<thead>
<tr>
<th>Course type</th>
<th>Comment</th>
<th>SWS</th>
<th>Frequency</th>
<th>Workload attendance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td></td>
<td>2.00</td>
<td>SuSe</td>
<td>28 h</td>
</tr>
<tr>
<td>Tutorial</td>
<td></td>
<td>2.00</td>
<td>SuSe</td>
<td>28 h</td>
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</table>

**Total time of attendance for the module**

56 h
inf131 - Advanced Topics in Human Computer Interaction

Module label: Advanced Topics in Human Computer Interaction

Module code: inf131

Credit points: 6.0 KP

Workload: 180 h

Used in course of study:
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Computing Science (Master) > Praktische Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction

Contact person

Module responsibility
- Susanne Boll-Westermann
- Die im Modul Lehrenden

Authorized examiners
- Die im Modul Lehrenden

Entry requirements

This course aims to provide a sample of some of the most recent and significant advances in this exciting area. Topics may include: situational awareness, designing for attention, ambient/peripheral interaction, computer support for cooperative work and social computing (CSWC), ubiquitous and context-aware computing, haptic and gestural interaction, audio interaction, gaze-based interaction, biometric interfaces, and embedded, physical and tangible computing, mobile and wearable interfaces.

This course is explicitly not focused on the methods used in HCI practice (i.e., user-centered design cycle), but rather focuses on (recent) research.

Course prerequisite: Mensch-Maschine-Interaktion (Human Computer Interaction)

Professional competences:
The students:
- Demonstrate a systematic understanding of knowledge and critical awareness of a selection of the recent research advances in the area of HCI
- Evaluate and critique recent developments in the field of HCI on scientific and technological grounds
- Develop ability to conceptualize, design, implement, and evaluate user-centered systems and techniques.
- Plan and implement exploratory projects directed at envisioning and prototyping novel interactive artifact

Methodological competences:
The students:
- Analyze, review and critique research papers
- Carry out original research from start to finish
- Summarize and present research findings
- Work in a team to produce and evaluate prototypes of novel interactive artifact

Social competences:
The students:
- Work collaboratively in groups to analyze and review research papers
- Summarize and present research findings to rest of class
- Discuss how HCI concepts and methods can be applied in analysis, design, and evaluation of interactive technologies.
- Discuss social and ethical implications of interactive technologies

Self-competences:
The students:
- Be comfortable tackling original research questions
- Aptitude in conceptualizing and running both qualitative and quantitative HCI experiments
- Ability to summarize, analyze, and critique published (peer-review) research papers

Module contents

HCI is a fast-growing field, where scientific research in this area crosses multiple disciplines. The body of theoretical and empirical knowledge that can inform the design of effective systems is rapidly developing, which underscores the importance of current research in the field.
This course aims to provide a sample of some of the most recent and significant advances in this exciting area. Topics may include: situational awareness, designing for attention, ambient/peripheral interaction, computer support cooperative work and social computing (CSCW), ubiquitous and context-aware computing, haptic and gestural interaction, audio interaction, gaze-based interaction, biometric interfaces, and embedded, physical and tangible computing, mobile and wearable interfaces.

Structure of the Module:

The course will consist of lectures and lab sessions. Lab sessions will cover assignments (writing paper reviews, presentations, and peer assessment). In addition to assignments and a final exam, a small part of the course includes a mini group-based HCI project.

Lectures: 2 hours per week
Lab: 2 hours per week

This lecture will be held in English. All assignment submissions and exams will be in English.

The primary audience for this class are Master students of Computer Science following the Human Computer Interaction track.

Reader's advisory

Suggested reading:


Links

Language of instruction: English
Duration (semesters): 1 Semester
Module frequency: Semi-annual
Module capacity: 24
Modullevel: AS (Akzentsetzung / Accentuation)
Modulart: Pflicht o. Wahlpflicht / compulsory or optional
Lern-/Lehrform / Type of program: V+P
Vorkenntnisse / Previous knowledge: Interaktive Systeme

Examination

Time of examination: At the end of the lecture period
Type of examination: Project and oral exams

Final exam of module

Missing the exam
If you cannot attend the exam with valid reasons (medical reason, exam schedule conflicts), you need to inform us before the exam, and submit a scanned copy of the evidence (medical certificate, course registration, boarding passes) within 5 days after the exam.
- If the reason for missing the exam is valid, you will do your first try of the exam for the parts that you missed on the same date as the second chance exam.
- If the reason is not valid, you will not get any score from that exam. If your overall score passed the course, you will not have a chance to take the exam again.

Grading:
Your grade will be calculated as follows:

<table>
<thead>
<tr>
<th>Scored Items</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final</td>
<td>40</td>
</tr>
<tr>
<td>Assignments A01-03</td>
<td>30</td>
</tr>
<tr>
<td>Mini HCI research project</td>
<td>20</td>
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</table>

<table>
<thead>
<tr>
<th>Course type</th>
<th>Comment</th>
<th>SWS</th>
<th>Frequency</th>
<th>Workload attendance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td></td>
<td>2.00</td>
<td>SuSe or WiSe</td>
<td>28 h</td>
</tr>
<tr>
<td>Practical</td>
<td></td>
<td>2.00</td>
<td>SuSe or WiSe</td>
<td>28 h</td>
</tr>
<tr>
<td>Course type</td>
<td>Comment</td>
<td>SWS</td>
<td>Frequency</td>
<td>Workload attendance</td>
</tr>
<tr>
<td>-------------</td>
<td>---------</td>
<td>-----</td>
<td>-----------</td>
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</tr>
<tr>
<td><strong>Total time of attendance for the module</strong></td>
<td></td>
<td></td>
<td></td>
<td>56 h</td>
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inf174 - Special Topics in 'Media Informatics and Multimedia Systems' II

<table>
<thead>
<tr>
<th>Module label</th>
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<tbody>
<tr>
<td>Module code</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>
</tr>
<tr>
<td>Used in course of study</td>
<td>Master's Programme Computing Science (Master) &gt; Praktische Informatik</td>
</tr>
<tr>
<td></td>
<td>Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Human-Computer Interaction</td>
</tr>
<tr>
<td>Contact person</td>
<td>Module responsibility</td>
</tr>
<tr>
<td></td>
<td>Susanne Boll-Westermann</td>
</tr>
<tr>
<td></td>
<td>Die im Modul Lehrenden</td>
</tr>
<tr>
<td></td>
<td>Module counseling</td>
</tr>
<tr>
<td></td>
<td>Die im Modul Lehrenden</td>
</tr>
<tr>
<td>Entry requirements</td>
<td>This module integrates current developments in the field in adequate study courses.</td>
</tr>
<tr>
<td>Skills to be acquired in this module</td>
<td>Professional competences</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>
</tr>
<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>
</tr>
<tr>
<td></td>
<td>• Discuss and evaluate recent computer science developments</td>
</tr>
<tr>
<td></td>
<td>Methodological competences</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>
<tr>
<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>Social competences</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>Self-competences</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>
</tbody>
</table>

Module contents: According to the assigned course

Reader's advisory: As announced in course

Languages of instruction: German, English

Duration (semesters): 1 Semester

Module frequency: irregular

Module capacity: unlimited

Modullevel: AC (Aufbaucurriculum / Composition)

Modulart: je nach Studiengang Pflicht oder Wahlpflicht

Lern-Lehrform / Type of program: 2 Veranst. aus V, S, Ü P, PR

Vorkenntnisse / Previous knowledge
<table>
<thead>
<tr>
<th>Examination</th>
<th>Time of examination</th>
<th>Type of examination</th>
</tr>
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<td>At the end of the lecture period</td>
<td>Portfolio or presentation or oral exam</td>
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<td>SWS</td>
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<tr>
<td>Frequency</td>
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<td></td>
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<tr>
<td>Workload attendance</td>
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inf175 - Special Topics in 'Media Informatics and Multimedia Systems' II

<table>
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<tr>
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<td>Credit points</td>
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<td>Workload</td>
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</table>
| Used in course of study             | - Master's Programme Computing Science (Master) > Praktische Informatik  
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction |
<p>| Contact person                      | Module responsibility                                           |
|                                    | - Susanne Boll-Westermann                                      |
|                                    | - Die im Modul Lehrenden                                        |
| Authorized examiners                | - Susanne Boll-Westermann                                      |
|                                    | - Die im Modul Lehrenden                                        |
| Entry requirements                  | This module integrates current developments in the field in adequate study courses. |
| Skills to be acquired in this module| 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                     | According to the assigned course                              |
| Reader's advisory                   | As announced in course                                        |
| Links                               |                                                               |
| Languages of instruction            | German, English                                               |
| Duration (semesters)                | 1 Semester                                                    |
| Module frequency                    | unregelmäßig                                                 |
| Module capacity                     | unlimited                                                    |
| Module level                        | AS (Akzentsetzung / Accentuation)                             |
| Modulart                            | je nach Studiengang Pflicht oder Wahlpflicht                  |
| Lern-/Lehrform / Type of program    | 2 Veranst. aus V, S, Ü, P, PR (4 SWS)                         |</p>
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<th>Time of examination</th>
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<tr>
<td>Workload attendance</td>
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inf301 - Machine-oriented Systems Engineering

Module label
Machine-oriented Systems Engineering

Module code
inf301

Credit points
6.0 KP

Workload
180 h

Used in course of study
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Contact person
Module responsibility
- Alfred Mikschl
- Die im Modul Lehrenden

Authorized examiners
- Alfred Mikschl
- Die im Modul Lehrenden

Entry 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

Module contents
Embedded systems support complex feedback problems, control problems and data processing tasks. They have an important value creation potential for telecommunications, production management, transport and electronics. The functionality of embedded systems is realised by the integration of processors, special hardware and software. The embedded systems design is influenced by the heterogeneity of system architectures, the complexity of systems and technical and economic requirements.

This module gives an initial review of computer architectures. After that embedded systems are introduced by a specific microprocessor. Furthermore, external hardware will be connected to the microprocessor. Besides this, the design of circuit boards will be discussed. The students will design, develop and implement a circuit layout with CAD and programme this embedded system with a Flash-eprom.

Reader's advisory
Lecturers notes, hardware manuals and data sheets, and development tool manuals

Links

Languages of instruction
English , German

Duration (semesters)
1 Semester

Module frequency
semi-annual

Module capacity
unlimited

Modullevel
AS (Akzentsetzung / Accentuation)

Modulart
Pflicht o. Wahlpflicht / compulsory or optional

Lern-/Lehrform / Type of program
V+P

Vorkenntnisse / Previous knowledge
<table>
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<td>Portfolio (Design, development and implementation of embedded systems, colloquium)</td>
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**Total time of attendance for the module** 56 h
inf303 - Fuzzy Control and Artificial Neural Networks in Robotics and Automation

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**Used in course of study**
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering
- Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies

**Contact person**

<table>
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<tr>
<td>Sergej Fatikow</td>
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<tr>
<td>Die im Modul Lehrenden</td>
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<table>
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<tbody>
<tr>
<td>Sergej Fatikow</td>
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<td>Die im Modul Lehrenden</td>
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</table>

**Entry requirements**

<table>
<thead>
<tr>
<th>Skills to be acquired in this module</th>
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</table>

- 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

Reader's advisory

Essential:

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

Recommended:


Secondary Literature:

- Altrock, M. O. R.: Fuzzy Logic, R. Oldenbourg Verlag, 1993
- Kahlerl, J. und Hubert, F.: "Fuzzy-Logik und Fuzzy-Control", Vieweg, 1993
- Kratzer, K.P.: Neuronale Netze, Carl Hanser, 1993
- Lawrence, J.: Neuronale Netze, Symthema Verlag, München, 1992
- Patterson, D.W.: "Künstliche neuraunale Netze",
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<tr>
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inf305 - Medical Technology

Module label: Medical Technology
Module code: inf305
Credit points: 6.0 KP
Workload: 180 h

Used in course of study
- Master's Programme Computing Science (Master) > Nicht Informatik
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Contact person
Module responsibility
- Andreas Hein

Authorized examiners
- Andreas Hein
- Die im Modul Lehrenden

Entry requirements
Skills to be acquired in this module

Professional competence
The students:
- Describe medical diagnosis and therapy methods
- Understand the core concepts of computer-assisted medical interventions
- Are aware of the basic concepts and legal conditions of the development of medical devices
- Define the character of medical devices' software parts and implement them
- Assess the complex interaction of medical products and patients
- Get familiar with the development of medical products within a short period of time

Methodological competence
The students:
- Recognise the interdisciplinary challenges and accordingly exchange information with other disciplines

Social competence
The students:
- Present solutions for specific questions

Self-competence
The students:
- reflect their solutions by using methods learned in this course

Module contents
- Medical areas and areas of application
- Basic requirements for medical systems (hygiene, MPG, technical security, materials)
- Medical systems:
  - Functional diagnostics (ECG, EMG, EEG)
  - Imaging systems (CT, MRI, ultrasound, PET, SPECT) - Therapy equipment (Laser, RF, Microtherapy)
- Signal processing / monitoring (cardiovascular, hemodynamic, respiratory, metabolic, cerebral)
- Medical Informatics (HIS, DICOM, Telemedicine, VR, image processing).

Reader's advisory
essential:

recommended:
- Lecture slides

**secondary literature:**


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### Links

<table>
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<th>Languages of instruction</th>
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<td>Duration (semesters)</td>
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<td>Module frequency</td>
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<tr>
<td>Module capacity</td>
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<tr>
<td>Modulelevel</td>
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<td>Modulart</td>
<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
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<tr>
<td>Lern-/Lehrform / Type of program</td>
<td>V+Ü</td>
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<td>- Signal und Bildverarbeitung</td>
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<tr>
<td></td>
<td>- Regelungstechnik</td>
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**Examination**

- Time of examination: Final exam of module
- Type of examination: Portfolio: Hands-on exercises, report, and written or oral exam

**Course type**

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<th>Frequency</th>
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<tbody>
<tr>
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<td>42 h</td>
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<td>1.00</td>
<td>WiSe</td>
<td>14 h</td>
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**Total time of attendance for the module**

56 h
Module label: Robotics
Module code: inf307
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- Master's Programme Computing Science (Master) > Nicht Informatik
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodul
- 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

Contact person:
Module responsibility:
- Andreas Hein
- Die im Modul Lehrenden

Authorized examiners:
- Die im Modul Lehrenden
- Andreas Hein

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

Reader's advisory

essential:
lecture nodes

recommended:

secondary literature:

Links

Languages of instruction
German, English

Duration (semesters)
1 Semester

Module frequency
once a year

Module capacity
unlimited

Module level
AS (Akzentsetzung / Accentuation)

Modular
Pflicht o. Wahlpflicht / compulsory or optional

Type of program
V+Ü

Previous knowledge

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

Course type
Comment
SWS
Frequency
Workload attendance
Lecture
3.00
SuSe
42 h
Exercises
1.00
SuSe
14 h

Total time of attendance for the module
56 h
inf308 - Microrobotics II

Module label: Microrobotics II
Module code: inf308
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- Master's Programme Computing Science (Master) > Nicht Informatik
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodul
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering
- Master's Programme Engineering Physics (Master) > Schwerpunkt: Laser and Optics

Contact person:
Module responsibility:
- Sergej Fatikow
- Die im Modul Lehrenden

Authorized examiners:
- Sergej Fatikow
- Die im Modul Lehrenden

Entry requirements:

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

Reader's advisory:
- Lecture notes (can be obtained in secretariate, A1-3-303)

<table>
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<tr>
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<td>Duration (semesters)</td>
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<td>Module frequency</td>
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<td>Module capacity</td>
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<td>Modulart</td>
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<tr>
<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
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<tr>
<td>Lern-/Lehrform / Type of program</td>
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<td>V+Ü</td>
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inf330 - Embedded Systems

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<td>Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Human-Computer Interaction</td>
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**Contact person**

Module responsibility

- Wolfgang Nebel
- Martin Georg Fränzle

Authorized examiners

- Die im Modul Lehrenden
- Wolfgang Nebel
- Martin Georg Fränzle

**Entry requirements**

**Skills to be acquired in this module**

This module provides an introduction to the design of digital embedded systems

**Professional competences:**

The students:

- Name functional and non-functional requirements to specify embedded systems
- Discuss design space and associated embedded systems design methods
- Name control and feedback control systems' core concepts
- Characterise the fundamental digital signal processing algorithms

**Methodological competences:**

The students:

- Design and develop embedded feedback control systems with modelling tools
- Implement an embedded hardware-/software system according to a given specification
- Analyze various specification languages according to different properties

**Social competences:**

The students:

- Implement solutions to given problems in teams
- Present results of computer science problems to groups
- Organize themselves as a team to solve a larger problem using project management methods

**Self-competences:**

The students:

- Acknowledge the limits of their ability to cope with pressure during the implementation process of systems
- Solve exercises self-responsibly

**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 overview of embedded systems and their design. The process of digital signals is especially important for telecommunications and multimedia. For this purpose, the module introduces digital signal processing algorithms. The principles of feedback control are introduced by exemplary transport applications. Subsequently, the module provides the specifications and language characteristics of the embedded system design. For this purpose, graphical data-flow modelling languages (for instance Simulink) and control-flow specifications (for instance State Charts) are presented. The module closes with the concepts of possible architectures and communication models.

Hands-on exercises with the tools Matlab/Simulink/StateFlow support the module contents.

**Reader's advisory**

Slides and

Secondary literature:
- Artikelserie zum MPEG-2-Standard 3/94 - 10/94 und das Tutorial "Digitale Bildcodierung" 1/92 - 1/93, beides in "Fernseh- und Knototechnik" (BIS: Zelt ZA 1538)

Links

Language of instruction: English

Duration (semesters): 1 Semester

Module frequency: jährlich

Module capacity: unlimited

Reference text:
- This module is compulsory for students who are specialising in "Eingebettete Systeme und Mikrorobotik".

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Vorkenntnisse / Previous knowledge

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Final exam of module

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<td>Exercises</td>
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Total time of attendance for the module: 56 h
inf333 - Sensor Technology in the Automotive Domain

Module label: Sensor Technology in the Automotive Domain
Module code: inf333
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- 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

Contact person
Module responsibility:
- Frank Köster
- Die im Modul Lehrenden

Authorized examiners:
- Die im Modul Lehrenden
- Frank Köster

Entry requirements

Skills to be acquired in this module
This module introduces the principles of sensors and sensor-systems as well as data-fusion in the automotive domain.

Professional competences:
The students:
- Discuss different levels/diverse levels sensor-technologies
- Discuss sensor-data fusion (multi-level fusion)
- Discuss Kalman-Filter
- Discuss in-vehicle data-processing
- Discuss car2cx-technologies
- Design simple multi-sensor systems
- Evaluate multi-sensor systems

Methodological competences:
The students:
- Analyze multi-sensor systems
- Design multi-sensor systems
- Evaluate multi-sensor systems

Social competences:
The students:
- Work in teams
- Discuss their outcomes appropriately

Self-competences:
The students:
- Acknowledge the limits of their ability to cope with pressure during the work on the topics of the module

Module contents
- Sensor-technologies
- Data fusion (multi-level fusion)
- Kalman-Filter
- In-vehicle data-processing
- Car2cx-technologies (ITS G5 and 5G)
- Multi-sensor and multi-level fusion architectures

Reader's advisory
Suggested reading:

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<td>Practikal Work and oral exam</td>
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<tr>
<td>Exercises</td>
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<td>28 h</td>
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| Total time of attendance for the module | |
|-----------------------------------------| 56 h |
inf336 - Application Area Automotive

Module label: Application Area Automotive
Module code: inf336
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- 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

Contact person
Module responsibility
- Frank Köster
- Die im Modul Lehrenden

Authorized examiners
- Die im Modul Lehrenden
- Frank Köster

Entry requirements

Skills to be acquired in this module
This module introduces the application area Automotive.

Professional competences: The students:
- Discuss core-concepts of the transportation domain
- Discuss different modes of transportation (focus on the automotive sector)
- Discuss automated and connected driving (short introduction/overview)
- Discuss human factors in the automotive sector
- Discuss traffic infrastructure (focus on intersections)
- Discuss basic principles in traffic management

Methodological competences: The students:
- Analyze vehicle systems
- Analyze traffic infrastructure
- Analyze cooperative vehicle/infrastructure systems
- Analyze socio-technical systems

Social competences: The students:
- Work in teams
- Discuss their outcomes appropriately

Self-competences: The students:
- Acknowledge the limits of their ability to cope with pressure during the work on the topics of the module

Module contents
- Core-concepts of the transportation domain
- Modes of transportation (focus on the automotive sector)
- Automated and connected driving (short introduction/overview)
- Human factors in the automotive sector
- Traffic infrastructure (focus on intersections)
- Basic principles in traffic management

Reader's advisory

Links

Language of instruction: English

Duration (semesters): 1 Semester

Module frequency: once a year

Module capacity: unlimited

Modullevel: AS (Akzentsetzung / Accentuation)

Modulart: Pflicht o. Wahlpflicht / compulsory or optional

Lern-/Lehrform / Type of program: V+Ü

Vorkenntnisse / Previous knowledge

Examination

Time of examination: At the end of the lecture period

Type of examination: Practical Work and oral Exam

Final exam of module

Course type: Lecture
Comment: 2.00
SWS: 2
Frequency: SuSe
Workload attendance: 28 h

Course type: Exercises
Comment: 2.00
SWS: 2
Frequency: SuSe
Workload attendance: 28 h

Total time of attendance for the module: 56 h
inf338 - Design of Autonomous Systems

Module label
Design of Autonomous Systems

Module code
inf338

Credit points
6.0 KP

Workload
180 h

Used in course of study
- 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

Contact person
Module responsibility
- Martin Georg Fränzle
- Die im Modul Lehrenden

Authorized examiners
- Die im Modul Lehrenden
- Martin Georg Fränzle

Entry requirements
Professional competences:
The students are enabled to analyze and build autonomous systems.

Methodological competences:
The students know examples of existing autonomous systems, understand the elements involved in their architectural design and the rationale behind decomposing the problem into obligations for the respective system components. The module furthermore enables the students to analyze existing architectures for autonomous systems with respect to their performance and safety. The students learn how to decompose a problem of designing an autonomous system into an architecture, are able to derive design obligations for its components, and can structure a pertinent safety case. They understand the software and hardware components necessary for achieving system autonomy and are able to design or instantiate these.

Social competences:
The students acquire hands-on experience in designing components for autonomous systems in small teams and present the underlying theory, their particular design decisions, and their personal evaluation to fellow students.

Self-competences:
The students can judge adequacy of their methodological skills for designing particular autonomous solutions. They are able to assess the safety impact of such a solution and are therefore able to develop a personal ethical stance towards its realization.

Module contents
The module consists of a lecture and an exercise part

Reader's advisory

Links
Language of instruction
English

Duration (semesters)
1 Semester

Module frequency
once a year

Module capacity
unlimited

Modullevel
AS (Akzentsetzung / Accentuation)

Modulart
Pflicht o. Wahlpflicht / compulsory or optional

Lern-Lehrgang / Type of program
V+Ü

Vorkenntnisse / Previous knowledge

Examination
Time of examination
Type of examination
Final exam of module
Second half of semester
Presentation

Course type
Comment
SWS
Frequency
Workload attendance
Lecture
2.00
SuSe or WiSe
28 h
Exercises
2.00
SuSe or WiSe
28 h

Total time of attendance for the module
56 h
inf522 - Information Processing in Bio-Medical Research

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<tr>
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Used in course of study
- Master's Programme Computing Science (Master) > Angewandte 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

Contact person
Module responsibility
- Rainer Röhrig
- Die im Modul Lehrenden

Authorized examiners
- Die im Modul Lehrenden
- Rainer Röhrig

Entry requirements

Skills to be acquired in this module
The students are aware of the requirements of biomedical research information processing and technologies. They know, develop and evaluate approaches.

Professional competences:
The students:
- Know the principles of biomedical research and identify resulting requirements and develop appropriate solutions
- Know the regulatory guidelines and assess the suitability of (IT) solutions or develop them
- Plan, apply, evaluate, report and assess IT solution evaluation studies
- Are aware of the biomedical research responsibility and the ethical challenges

Methodological competences:
The students:
- Search literature systematically
- Plan and assess clinical studies
- Develop concepts for a data privacy and GCP conform study management
- Know and apply medical classification systems
- Validate and run software for clinical trials, cohorts and registries
- Plan and assess healthcare IT studies

Social competences:
The students:
- Present solutions/results
- Discuss studies constructively, professionally and appropriately
- Discuss ethical biomedical research problems from different points of view

Self-competences:
The students:
- Reflect their own values and attitudes in the context of medical and biomedical research border areas
- Reflect their self-capacity with regard to the responsibility and the workload during the implementation of studies and the operation of study information systems

Module contents
- Basics / Biomedical research theory
- Systematic literature research, repositories
- Study schedule and method design
- Biomedical research regulatory framework
- Biomedical research ethics
- IT infrastructure in research / IT components incl. molecular medicine
- (Data) privacy
Operating of software for clinical trials, cohorts and registries
Clinical study report standards (Equator-Network), review process
Evaluation of healthcare IT (GEP-HI and STARE-HI) / evidence based healthcare informatics

Reader's advisory
Wird im Modul bekannt gegeben

Links

Languages of instruction
German, English

Duration (semesters)
1 Semester

Module frequency
once a year

Module capacity
unlimited

Module level
AS (Akzentsetzung / Accentuation)

Modular
je nach Studiengang Pflicht oder Wahlpflicht

Lern-/Lehrform / Type of program
V+Ü

Vorkenntnisse / Previous knowledge
Medizin für Informatiker, Statistik

Examination
Time of examination
Written exam

Final exam of module
At the end of the lecture period

Course type
Lecture
Exercises

Comment

SWS
2.00
2.00

Frequency
SuSe
SuSe

Workload attendance
28 h
28 h

Total time of attendance for the module
56 h
inf523 - Medical Software Engineering

Module label  Medical Software Engineering
Module code  inf523
Credit points  6.0 KP
Workload  180 h

Used in course of study
- Master's Programme Computing Science (Master) > Angewandte 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

Contact person
Module responsibility
- Rainer Röhrig

Authorized examiners
- Die im Modul Lehrenden
- Rainer Röhrig

Entry requirements
Skills to be acquired in this module
This Module provides the regulatory requirements of medical software. Focus is on software life cycle methods and approaches, the implementation of combined usability- and risk management processes as well as quality management.

Professional competence
The students:
- Know and use obligatory medical software requirements
- Know methods and approaches to develop security-critical medical software and implement them by example
- Know at least one medical application area and its specific professional, organisational and regulatory requirements

Methodological competence
The students:
- Are able to apply risk management methods of socio-technical systems
- Are able to extend their knowledge of new application areas. They are able to handle the obstacles of normative frameworks and software development.

Social competence
The students:
- Realise the importance of communication during the software development process between developer, customer and user of a successful and secure system. Feedback, request, respectful cooperation and empathy of other disciplines’ working processes are of great importance.

Self-competence
The students:
- Realise their responsibility as a computer scientist and reflect their impact on patients, medical employers and hospitals (corporates)

Module contents
Content of the Module:
This module provides medical software development processes. The module deals with normative software requirements with the focus on patient privacy and quality management. Contents are the declaration of conformity based on medical product classes and software security classes. The software security is focused on software quality, tests and verification, validation as well as quality and risk management. The software life cycle provides security related systems and software as well as software architecture and different process models.

Reader's advisory
wird im Modul bekannt gegeben

Links

Languages of instruction
German, English
**Duration (semesters)**  
1 Semester

**Module frequency**  
once a year

**Module capacity**  
unlimited

**Modullevel**  
AS (Akzentsetzung / Accentuation)

**Modulart**  
Pflicht o. Wahlpflicht / compulsory or optional

**Lern-Lehrform / Type of program**  
V + Ü

**Vorkenntnisse / Previous knowledge**  
Medizin für Informatiker  
Programmierkenntnisse / Softwareentwicklung / Informationssysteme / Mensch Maschine Interaktion

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**Total time of attendance for the module**  
56 h
inf532 - Introduction to Cognitive Engineering

<table>
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**Contact person**

- Module responsibility
  - Sebastian Feuerstack
  - Die im Modul Lehrenden
- Authorized examiners
  - Sebastian Feuerstack
  - Die im Modul Lehrenden

**Entry requirements**

**Skills to be acquired in this module**

**Professional competences:**

The students:
- Understanding of state of the art methods, techniques and tools (MTTs) to describe, model and evaluate human performance in safety-critical systems.
- Basic understanding of cognitive modeling and state of the art cognitive architectures
- Application of MTTs for use cases applications in Automotive, ATC, Maritime, Healthcare and Energy.
- Understanding of model-based user interface engineering, which derives human machine interface designs based on models.

**Methodological competences:**

The students:

- Select and apply MTTs to predict human performance, in particular for:
  - task analysis, design and modeling
  - modelling and prediction human visual attention while monitoring complex systems,
  - task performance and workload prediction based on cognitive architectures.

**Social competences:**

The students: --

**Self-competences:**

The students:
- Solve analysis, design and modelling tasks
- Model-based thinking

**Module contents**

The module aims at students from computer science, engineering, and psychology that are interested in getting and understanding into analyzing the impact of a human-machine interface to a human operator's performance and well-being.

Computer programming skills are not required, but an interest in applying computer programs to model human behavior as part of the practical exercise is expected.

The module consists of a lecture and an exercise part:

**Lecture:**

The module introduces the field of cognitive engineering, which is an emerging branch of human factors and ergonomics and places particular emphasis on the structured analysis of cognitive processes required of operators in safety-critical applications. The lecture puts specific emphasis on models and processes for task analysis (i.e. ConcurTaskTrees), visual attention (i.e. SEEV), human performance (i.e. modern GOMS variants) and also introduce cognitive modelling based on cognitive architectures, which implement psychological and physiological plausible models to explain and predict human performance (i.e. ACT-R and CASCaS). Besides these approaches that are mostly targeted to systematically evaluate interactive systems, we also spend time on introducing "constructive" design methods (i.e. based on ecological interface design) to optimize human machine interfaces so that they can be efficiently used and perceived.

**Exercises:**

Based on the examples (e.g. managing incoming flights at air traffic control, driving a car in complex overtaking scenarios or performing time critical interventions with robots in an operation theater) that we introduce in the lecture to explain and discuss the theoretical models of e.g. human attention, or human performance prediction, we aim at modeling these examples in the exercises in our lab to end up with concrete human performance predictions.

**Reader's advisory**

Each lecture covers usually a specific chapter of one of the following books or articles:
- Model-Based Design and Evaluation of Interactive Applications (Fabio Paternò)
- Introduction to ACT-R (John R. Anderson, Christian Lebiere)
- Engineering Psychology and Human Performance (Chris Wickens, Justin Hollands)
- Ecological interface design: Progress and challenges. Human Factors (Kim Vicente)
- Cognitive Work Analysis: Toward Safe, Productive, and Healthy Computer-Based Work (Kim Vicente)
- The psychology of Human Computer Interaction (Card, Moran, Newell)

Links
http://www.humanics.eu

Language of instruction
English

Duration (semesters)
1 Semester

Module frequency

Module capacity
unlimited

Reference text
Associated with the module(s):
Application Area Automotive
Usability in Medicine

Modullevel
AC (Aufbaucurriculum / Composition)

Modulart
Pflicht o. Wahlpflicht / compulsory or optional

Lern-/Lehrform / Type of program
V+Ü

Vorkenntnisse / Previous knowledge

Examination
Time of examination
Type of examination

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

Course type
Comment
SWS
Frequency
Workload attendance

Lecture
2.00
SuSe and WiSe
28 h

Exercises
2.00
SuSe and WiSe
28 h

Total time of attendance for the module
56 h
### inf535 - Computational Intelligence I

<table>
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#### Used in course of study
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte 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 Environmental Modelling (Master) > Mastermodule

#### Contact person
- Module responsibility
  - Oliver Kramer
  - Die im Modul Lehrenden
- Authorized examiners
  - Oliver Kramer
  - Die im Modul Lehrenden

#### Entry requirements

#### Skills to be acquired in this module

**Professional competence:**
- The students:
  - recognise optimisation problems
  - implement simple algorithms of heuristic optimisation
  - critically discuss solutions and selection of methods
  - deepen previous knowledge of analysis and linear algebra

**Methodological competence**
- The students:
  - deepen programming skills
  - apply modelling skills
  - learn about the relation between problem class and method selection

**Social competence**
- The students:
  - cooperatively implement content introduced in lecture
  - evaluate own solutions and compare them with those of their peers

**Self-competence**
- The students:
  - evaluate own skills with reference to peers
  - realize personal limitations
  - adapt own problem solving approaches with reference to required method competences

#### Module contents
Computational Intelligence comprises intelligent and adaptive methods for optimisation and learning. The module "Computational Intelligence I" concentrates on methods for evolutionary optimisation and heuristic approaches. The exercises introduce and deepen practical aspects of the implementation and algorithmic design, also taking into account application aspects.

**Overview of Content:**
- foundations of optimisation
- genetic algorithms and evolution strategies
- parameter control and self-adaptation
- runtime analysis
- swarm algorithms
- constrained optimisation
- multi-objective optimisation
- meta-modeling
### Reader's advisory

### Links

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<th>Languages of Instruction</th>
<th>English, German</th>
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### Languages of instruction
- English, German

### Duration (semesters)
- 1 Semester

### Module frequency
- Jährlich

### Module capacity
- Unlimited

### Modulelevel
- AS (Akzentsetzung / Accentuation)

### Lern-/Lehrform / Type of program
- Je nach Studiengang Pflicht oder Wahlpflicht

### Vorkenntnisse / Previous knowledge
- Grundlagen der Statistik

### Examination
- Time of examination
- Type of examination

### Final exam of module
- At the end of the lecture period
- Written or oral exam

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### Total time of attendance for the module
- 56 h
## inf536 - Computational Intelligence II

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**Used in course of study**
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte 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 Environmental Modelling (Master) > Mastermodule

**Contact person**
- Module responsibility
  - Oliver Kramer
- Authorized examiners
  - Die im Modul Lehrenden
  - Oliver Kramer

**Entry requirements**

**Skills to be acquired in this module**

**Professional competence**
The students:
- Recognise machine learning problems
- Implement simple algorithms of machine learning
- Critically discuss solutions and selection of methods
- Deepen previous knowledge of analysis and linear algebra

**Methodological competence**
The students:
- Deepen programming skills
- Apply modelling skills
- Learn about the relation between problem class and method selection

**Social competence**
The students:
- Cooperatively implement content introduced in lecture
- Evaluate own solutions and compare them with those of their peers

**Self-competence**
The students:
- Evaluate own skills w.r.t. peers
- Realise personal limitations
- Adapt own problem solving approaches w.r.t. required method competences

**Module contents**
Computational Intelligence comprises intelligent and adaptive methods for optimisation and learning. The module "Computational Intelligence II" concentrates on methods for machine learning and data mining. The exercises introduce and deepen practical aspects of the implementation and algorithmic design, also taking into account application aspects.

**Overview of Content:**
- Foundations of learning and classification
- Nearest neighbouring methods
- Model selection and parameter tuning
- Regression
- Support vector and kernel methods
- Clustering
- Dimensionality reduction
Reader's advisory

- HASTIE, T., TIBSHIRANI, R., FRIEDMAN, J.H.: The Elements of Statistical Learning, Springer 2009

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<td>Module level</td>
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<td>Exercises</td>
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</table>
inf537 - Intelligent Systems

Module label: Intelligent Systems
Module code: inf537
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte 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

Contact person:
Module responsibility:
- Jürgen Sauer
- Die im Modul Lehrenden

Authorized examiners:
- Jürgen Sauer
- Die im Modul Lehrenden

Entry requirements:
**Professional competence**
The students:
- name the structure of agent-based systems
- use problem-solving methods for complex problems
- characterise the application area of process planning
- evaluate the suitability of processes regarding to specific problems

**Methodological competence**
The students:
- assign problem-solving methods to different problems

**Social competence**
The students:
- implement selected methods in small teams

**Self-competence**
The students:
- develop own solutions for given problems

Module contents:
A lot of application areas use "intelligent" problem-solving methods. These are the main focus of this lecture. They will be illustrated by examples in order to enhance the students' problem-solving abilities. These include:
- A brief introduction into AI
- Agent systems
- Solution methods of AI like heuristics, meta-heuristics, soft computing methods.

To apply and foster the contents of the lecture, an intelligent planning system is implemented in practical exercises.

Reader's advisory:
Suggested reading:
- Ghallab/Nau/Traverso: Automated Planning, Morgan Kaufman, 2004

Links:
www.wi-ol.de

Languages of instruction:
German, English

Duration (semesters):
1 Semester

Module frequency:
one a year

Module capacity:
unlimited

Reference text:
Dieses Modul ist im Rahmen der Projekte FiIF und FoL konzipiert worden

Module level:
AS (Akzentsetzung / Accentuation)

Lern-/Lehrform / Type of program:
V+Ü

Vorkenntnisse / Previous knowledge:
Produktionsorientierte Wirtschaftsinformatik

Examination:
Time of examination:
Final exam of module:
At the end of the lecture period
Practical exercises and oral exam or practical exercises and written exam or portfolio

Course type:
Lecture
Exercises

Comment:

SWS:
2.00
2.00

Frequency:
SuSe
SuSe

Workload attendance:
28 h
28 h

Total time of attendance for the module:
56 h
### inf551 - Maritime Systems

**Module label**  
Maritime Systems

**Module code**  
inf551

**Credit points**  
6.0 KP

**Workload**  
180 h

**Used in course of study**
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte 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

**Contact person**
- Module responsibility
  - Axel Hahn
  - Die im Modul Lehrenden
- Authorized examiners
  - Axel Hahn
  - Die im Modul Lehrenden

**Entry requirements**

**Skills to be acquired in this module**
The module deals with the economic aspects and synergy effects of maritime sub-areas. In addition to the basic knowledge of the maritime sub-areas, current approaches from research are taught. The basic ship parameters are examined with regard to their economic efficiency, stability calculations and ship dynamics are derived and effects of the ship hull, propellers and systems on the economic efficiency of a ship are considered. The focus here is on understanding economic thinking and the interaction of the sub-areas. Furthermore, future-oriented solutions and trends will be discussed. **Professional competence** The students - name the basics of planning and control of operational logistics in a shipyard - name the basics of planning of economic design - recognise the application possibilities of simulation in design, construction and dynamics - identify the basic maritime sub-areas and their synergies **Methodological competence** The students - Link relations with tree structures - Illustrate the questions and concepts of the design process **Social competence** The students - Present computational problem solving to groups - Discuss their outcomes appropriately - Implement solutions of given problems in teams - Accept criticism of their peer group as valuable contributions **Self-competence** The students - reflect their self-image and their actions of their results

**Module contents**

**Reader's advisory**

**Links**
http://www.wi-ol.de

**Languages of instruction**
German, English

**Duration (semesters)**
1 Semester

**Module capacity**
unlimited

**Module level**
AS (Akzentsetzung / Accentuation)

**Module type**
Wahlmodul / Opportunity

**Lern-/Lehrform / Type of program**
V + Ü

**Vorkenntnisse / Previous knowledge**
Transportsysteme, Analysis, Differentialgleichungen, lineare Algebra, Mechanik

**Examination**
- Time of examination: at the end of the lecture period
- Type of examination: practical exercises and oral examination

**Course type**
- **Lecture**: 2.00 SWS, WiSe, 28 h
- **Exercises**: 2.00 SWS, WiSe, 28 h
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inf663 - Application Area Maritime

Module label Application Area Maritime
Module code inf663
Credit points 6.0 KP
Workload 180 h

Used in course of study
- Master's Programme Computing Science (Master) > Angewandte 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

Contact person
Module responsibility
- Axel Hahn
Die im Modul Lehrenden
Authorized examiners
- Axel Hahn
- Die im Modul Lehrenden

Entry requirements
Skills to be acquired in this module
Professional competences:
The students gain knowledge about ship handling and navigation and learn to understand maritime transportation as a system of systems with systems on board for stability, propulsion and steering as for bridge resource management. They understand the latter as a major contribution to organize navigation as a hierarchical team concept of a safety critical sociotechnical system. The students are aware of the special technical and physical challenges of navigation.

Methodological competences:
The students can apply system engineering methods to describe, analyse and design maritime systems. By looking on maritime transporation the gain transferable knowledge on other cyber physical systems. Students learned to how systems can deal with harsh environmental conditions in a resilient way.

Social competences:
Maritime transportation is a mayor basis of a global economy. Typically, students do not have an understanding of these transportation systems nor their technical and systemic challenges. Therefore, the student knows the concepts of maritime transportation and its role in international transportation networks after finishing this module.

Self-Competences:
Especially their competences cover an understanding as maritime transportation as a systems of system with high requirements on reliability, dependability and safety in combination with efficiency to be competitive in a global economy.

Module contents
The module consists of a lecture and an exercise part:
Lecture: - Maritime Transportation in global and local supply chains, Base concepts of ship handling and navigation, maritime system dynamics, bridge resource management, eNAvigation and high automation systems.
Seminar: Covering aspects of maritime transportation

Reader's advisory
Bernhard Berking, Werner Huth (Herausgeber), Handbuch Nautik 1: Navigatorische Schiffsführung, Seehafen Verlag, 2010

Links
Language of instruction English
Duration (semesters) 1 Semester
Module frequency Once a year
Module capacity unlimited
Modullevel AS (Akzentsetzung / Accentuation)
Modulart Pflicht o. Wahlpflicht / compulsory or optional
Lern-/Lehrform / Type of program V+S

Vorkenntnisse / Previous knowledge
Examination Time of examination Type of examination
Final exam of module At the end of the lecture period Oral exam and documentation
Course type Comment SWS Frequency Workload attendance
Lecture 2.00 SuSe and WiSe 28 h

58 / 174
<table>
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**Total time of attendance for the module**  
56 h
inf50 - Transport Systems

**Module label**
Transport Systems

**Module code**
inf50

**Credit points**
6.0 KP

**Workload**
180 h

**Used in course of study**
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte 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

**Contact person**
Module responsibility
- Axel Hahn
- Die im Modul Lehrenden

Authorized examiners
- Axel Hahn
- Die im Modul Lehrenden

**Entry requirements**

**Skills to be acquired in this module**

**Objective of the module/skills:**
The Module Transport systems deals with planning and controlling systems of internal and external company logistics as well as public transport. It provides basic knowledge and recent research topics. The focus is on a resource orientated holistic view of company logistics as well as the planning of transport infrastructure. Furthermore, trends such as autonomous vehicles and intelligent transport systems are discussed.

**Professional competence**
The students:
- name the basics of planning and controlling company logistics
- assess transport systems of companies
- name methods and approaches of computer aided transport systems and classify them
- characterise software to plan complex logistics

**Methodological competence**
The students:
- display topics and concepts of transport systems
- simulate transport and its systems with appropriate methods

**Social competence**
The students:
- work in groups
- discuss their results appropriately

**Self-competence**
The students:
- realise their limits while working on a project containing aspects of modelling and implementation
- question the presentation of their results

**Module contents**
- Transport and logistics concepts
- Data acquisition of company logistics
- Planning- and simulation software for complex logistics- and transport processes
- Energy- and resource efficient transport systems
- Resource orientated transport cost calculations (e.g. CO2, noise pollution)
- Planning models for transport infrastructure

**Reader's advisory**

**Suggested reading:**

<table>
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<th>Links</th>
<th><a href="http://wi-ol.de">http://wi-ol.de</a></th>
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<tr>
<td>Languages of Instruction</td>
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<td>Exercises</td>
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<td>SuSe</td>
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| Total time of attendance for the module | 56 h |
Embedded Brain Computer Interaction

inf100 - Human Computer Interaction

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|                       | Master's Programme Computing Science (Master) > Praktische Informatik
|                       | Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodul
|                       | 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 |

Contact person

Module responsibility
- Susanne Boll-Westermann
- Die im Modul Lehrenden

Authorized examiners
- Susanne Boll-Westermann
- Die im Modul Lehrenden

Entry requirements

Skills to be acquired in this module
Professional competence
The students:
- Name the human-computer interaction core principles
- Characterise the basic elements of the human-centered design of interactive systems

Methodological competence
The students:
- Comprehend context of use and user requirements of human-machine interfaces
- Design, develop and evaluate human-machine interfaces
- Conduct experiments with their prototypes

Social competence
The students:
- Implement human-computer interfaces in practical hands-on projects in teams
- Evaluate human-machine interfaces with potential users
- Develop and present solutions for Human-Computer Interaction related problems
- Integrate technical and factual comments into own results

Module contents
The module introduces the field of human-computer interfaces and their historical context. Moreover, it shows motivating examples of human-computer interaction. The module covers the core principles of human-computer interaction. In detail, the module deals with the design concepts of interactive systems: context of use, requirements and task analysis, human perception capabilities, design process, usability, prototyping and evaluation. During the practical project a concrete human-computer interface will be designed, developed and evaluated according to this concepts.

Reader's advisory

- Markus Dahm, Grundlagen der Mensch Computer-Interaktion, Pearson, 2006
- Literature in the reserve shelf in the university bibliography. Link list in Stud.IP.

Links
- medien.informatik.uni-oldenburg.de/lehre

Languages of instruction
- German, English

Duration (semesters)
- 1 Semester

Module frequency
- once a year

Module capacity
- unlimited
<table>
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<th>Type of examination</th>
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<td>Final exam of module</td>
<td>The completed practical projects will be presented on a single project day, which will take place at the end of the lecture period. The oral exam takes place within the last two weeks of the lecture period. If necessary, re-examinations will take place at the end of the term. Find out more about the schedule on the websites of the department and in Stud.IP.</td>
<td>Practical group project which progress has to be presented regularly during the tutorials. Oral exam on the topics of the lecture. Practical project and oral exam count 50% each to the final grade. Both practical project and oral exam have to be passed individually.</td>
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<td>2.00</td>
<td>SuSe</td>
<td>28 h</td>
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| Total time of attendance for the module | 56 h |
inf300 - Hybrid Systems

Module label
Hybrid Systems

Module code
inf300

Credit points
6.0 KP

Workload
180 h

Used in course of study
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Computing Science (Master) > Theoretische Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmbodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Contact person
Module responsibility
- Martin Georg Fränzle
- Die im Modul Lehrenden

Authorized examiners
- Martin Georg Fränzle
- Die im Modul Lehrenden

Entry requirements

Skills to be acquired in this module
The module gives an introduction to hybrid discrete-continuous systems, as arising by embedding digital hardware into physical environments, and it elaborates on state of the art methods for the mathematical modelling and the analysis of such systems. It thus provides central competences for understanding and designing reliable cyber-physical systems.

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

Methodological 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 interleavings between discrete computational and decision processes and continuous processes. The resulting processes are neither amenable to the analytic techniques of continuous control nor of discrete mathematics. They instead require a broader, integrated theory: hybrid discrete-continuous systems. The lectures provide an in-depth introduction into a variety of analysis and design methods of these computer-based
systems and their recent extensions to cyber-physical systems

The accompanying hands-on-project enhances the lecture by developing and using design and verification tools.

**Reader's advisory**


**Links**

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<tr>
<th>Languages of instruction</th>
<th>English, German</th>
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<tr>
<td>Duration (semesters)</td>
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<td>V+Ü</td>
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<tr>
<td>Examination</td>
<td>Time of examination</td>
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<tr>
<td>Final exam of module</td>
<td>At the end of the lecture period</td>
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- **Course type**  
- **Comment**  
- **SWS**  
- **Frequency**  
- **Workload attendance**

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**Total time of attendance for the module**  
56 h
# inf301 - Machine-oriented Systems Engineering

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**Used in course of study**
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungmodule
- 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

**Contact person**
- Module responsibility
  - Alfred Mikschl
  - Die im Modul Lehrenden
- Authorized examiners
  - Alfred Mikschl
  - Die im Modul Lehrenden

**Entry requirements**

**Skills to be acquired in this module**

**Professional competence**
The students:
- characterise the structure of microprocessor systems
- name control aspects of time sensitive external components
- program efficient embedded systems

**Methodological competence**
The students:
- use specifications from electrical components data sheets

**Social competence**
The students:
- work in a team
- discuss solutions

**Module contents**
Embedded systems support complex feedback problems, control problems and data processing tasks. They have an important value creation potential for telecommunications, production management, transport and electronics. The functionality of embedded systems is realised by the integration of processors, special hardware and software. The embedded systems design is influenced by the heterogeneity of system architectures, the complexity of systems and technical and economic requirements.

This module gives an initial review of computer architectures. After that embedded systems are introduced by a specific microprocessor. Furthermore, external hardware will be connected to the microprocessor. Besides this, the design of circuit boards will be discussed. The students will design, develop and implement a circuit layout with CAD and programme this embedded system with a Flash-eprom.

**Reader's advisory**
Lecturers notes, hardware manuals and data sheets, and development tool manuals

**Links**

**Languages of instruction**
English, German

**Duration (semesters)**
1 Semester

**Module frequency**
semi-annual

**Module capacity**
unlimited

**Modullevel**
AS (Akzentsetzung / Accentuation)

**Modulart**
Pflicht o. Wahlpflicht / compulsory or optional

**Lern-/Lehrform / Type of program**
V+P

**Vorkenntnisse / Previous knowledge**
<table>
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<th>Examination</th>
<th>Time of examination</th>
<th>Type of examination</th>
</tr>
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<tbody>
<tr>
<td>Final exam of module</td>
<td>At the end of the lecture period</td>
<td>Portfolio (Design, development and implementation of embedded systems, colloquium)</td>
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<tr>
<td>Practical</td>
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<td>2.00</td>
<td>WiSe</td>
<td>28 h</td>
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**Total time of attendance for the module** 56 h
inf303 - Fuzzy Control and Artificial Neural Networks in Robotics and Automation

**Module code**
inf303

**Credit points**
6.0 KP

**Workload**
180 h

**Used in course of study**
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodul
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering
- Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies

**Contact person**

**Module responsibility**
- Sergej Fatikow
- Die im Modul Lehrenden

**Authorized examiners**
- Sergej Fatikow
- Die im Modul Lehrenden

**Entry 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,
- characterise the combination of fuzzy logic and ANN in control systems

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

**Social competence**
The students:
- gain experience in interdisciplinary work
- are integrated into the recent research work

**Objective of the module / skills:**

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

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

Reader’s advisory

Essential:

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

Recommended:

• Kahlert, J.: Fuzzy Control für Ingenieure, Vieweg, Braunschweig Wiesbaden, 1995
• Zell, A.: Simulation Neuronaler Netze, Addison-Wesley / Oldenbourg Verlag, Bonn, 1996

Secondary Literature:

• Altrock, M. O. R.: Fuzzy Logic, R. Oldenbourg Verlag, 1993
• Kahlert, J. und Hubert, F.: Fuzzy-Logik und Fuzzy-Control, Vieweg, 1993
• Kratzer, K.P.: Neuronale Netze, Carl Hanser, 1993
• Lawrence, J.: Neuronale Netze, Systhema Verlag, München, 1992
• Omidvar, O. and van der Smagt, P. (eds.): Neural Networks for Robotics, Academic Press, 1997
• Patterson, D.W.: Künstliche neuronale Netze, Prentice Hall, 1996
• Pham, D.T. a200
• nd Liu, X.: Neural Networks for Identification, Prediction and Control, Springer, 1997
• Rigoll, G.: Neuronale Netze, Expert Verlag, Rennningen-Malsmhein, 1994
• Schulte, U.: Einführung in Fuzzy-Logik, Franzis-Verlag, München, 1993
• von Altrock, C.: Fuzzy Logic: Technologie, Oldenbourg, 1993
• Zakharian, 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

once a year

Module capacity

unlimited

Modullevel

AS (Akzentsetzung / Accentuation)

Modulart

Pflicht o. Wahlpflicht / compulsory or optional

Lern-/Lehrform / Type of program

V+i Ü

Vorkenntnisse / Previous knowledge

Regelungstechnik

Examination

Time of examination

Final exam of module

At the end of the lecture period until the beginning

Hands-on-exercises and oral Exam
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<tr>
<th>Examination</th>
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<th>Type of examination</th>
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<th>SWS</th>
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<td><strong>56 h</strong></td>
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inf305 - Medical Technology

Module label: Medical Technology
Module code: inf305
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- Master's Programme Computing Science (Master) > Nicht Informatik
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Contact person:
Module responsibility:
- Andreas Hein
Authorized examiners:
- Andreas Hein
- Die im Modul Lehrenden

Entry requirements:
Skills to be acquired in this module:

Professional competence
The students:
- Describe medical diagnosis and therapy methods
- Understand the core concepts of computer-assisted medical interventions
- Are aware of the basic concepts and legal conditions of the development of medical devices
- Define the character of medical devices' software parts and implement them
- Assess the complex interaction of medical products and patients
- Get familiar with the development of medical products within a short period of time

Methodological competence
The students:
- Recognise the interdisciplinary challenges and accordingly exchange information with other disciplines

Social competence
The students:
- Present solutions for specific questions

Self-competence
The students:
- reflect their solutions by using methods learned in this course

Module contents
- Medical areas and areas of application
- Basic requirements for medical systems (hygiene, MPG, technical security, materials)
- Medical systems:
  - Functional diagnostics (ECG, EMG, EEG)
- Imaging systems (CT, MRI, ultrasound, PET, SPECT) - Therapy equipment (Laser, RF, Microtherapy)
- Signal processing / monitoring (cardiovascular, hemodynamic, respiratory, metabolic, cerebral)
- Medical Informatics (HIS, DICOM, Telemedicine, VR, image processing).

Reader's advisory:
essential:

recommended:
secondary literature:


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<td>Module capacity</td>
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<td>Signal und Bildverarbeitung, Regelungstechnik</td>
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<td>Examination</td>
<td>Time of examinationPortfolio: Hands-on exercises, report, and written or oral exam</td>
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<td>Exercises</td>
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<td>1.00</td>
<td>WISe</td>
<td>14 h</td>
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</table>

Total time of attendance for the module 56 h
inf307 - Robotics

Module label: Robotics
Module code: inf307
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- Master's Programme Computing Science (Master) > Nicht Informatik
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Embedded Systems and MicroRobotics (Master) > Akzentsetzungsmodul
- 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

Contact person:
Module responsibility:
- Andreas Hein
- Die im Modul Lehrenden

Authorized examiners:
- Die im Modul Lehrenden
- Andreas Hein

Entry 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

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<tr>
<th>Reader's advisory</th>
<th>essential:</th>
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<tr>
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Languages of instruction           | German, English |
Duration (semesters)               | 1 Semester     |
Module frequency                   | once a year     |
Module capacity                    | unlimited       |
Modulelevel                        | AS (Akzentsetzung / Accentuation) |
Modulart                           | Pflicht o. Wahlpflicht / compulsory or optional |
Lern-/Lehrform / Type of program   | V+Ü              |

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

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<th>Workload attendance</th>
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<tbody>
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<td>56 h</td>
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</table>
inf308 - Microrobotics II

Module label: Microrobotics II
Module code: inf308
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- Master's Programme Computing Science (Master) > Nicht Informatik
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering
- Master's Programme Engineering Physics (Master) > Schwerpunkt: Laser and Optics

Contact person

Module responsibility
- Sergej Fatikow
- Die im Modul Lehrenden

Authorized examiners
- Sergej Fatikow
- Die im Modul Lehrenden

Entry requirements

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

Reader's advisory
- Lecture notes (can be obtained in secretariate, A1-3-303)
<table>
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<td>Duration (semesters)</td>
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<td>Module frequency</td>
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<td>Modullevel</td>
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<td>Modulart</td>
<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
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<td>Lern-/Lehrform / Type of program</td>
<td>V+Ü</td>
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<td>Mikrorobotik und Mikrosystemtechnik</td>
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<th>Type of examination</th>
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<td>At the end of the lecture period</td>
<td>Oral Exam and exercises</td>
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<th>SWS</th>
<th>Frequency</th>
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<tr>
<td>Lecture</td>
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<td>3.00</td>
<td>SuSe</td>
<td>42 h</td>
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<td>Exercises</td>
<td></td>
<td>1.00</td>
<td>SuSe</td>
<td>14 h</td>
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</table>

**Total time of attendance for the module**: 56 h
inf311 - Low Energy System Design

Module label: Low Energy System Design
Module code: inf311
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Embedded Systems and Microrobots (Master) > Akzentsetzungsmodul
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Contact person
Module responsibility
- Wolfgang Nebel
- Die im Modul Lehrenden

Authorized examiners
- Die im Modul Lehrenden
- Wolfgang Nebel

Entry requirements
This module introduces the estimation of power dissipation and optimisation.

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.

Reader's advisory
- Designing CMOS Circuits for Low Power – Dimitros Soudris, Christian Piguet, Costas Goutis
- Low-Power CMOS VLSI Circuit Design – Kaushik Roy, Sharat C. Prasad
<table>
<thead>
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<td>Duration (semesters)</td>
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<tr>
<td>Lern-/Lehrform / Type of program</td>
<td>V+Ü</td>
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| Vorkenntnisse / Previous knowledge | - inf200 Grundlagen der Technische Informatik,  
- inf201 Technische Informatik,  
- inf203 Eingebettete Systeme I,  
- inf204 Eingebettete Systeme II |
| Examination | Time of examination hands-on exercises and oral exam |
| Final exam of module | at the end of the lecture period |
| Course type | Comment | SWS | Frequency | Workload attendance |
| Lecture |  | 2.00 | WiSe | 28 h |
| Exercises |  | 2.00 | WiSe | 28 h |
| Total time of attendance for the module | 56 h |
inf331 - Automated and Connected Driving

Module label: Automated and Connected Driving
Module code: inf331
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction

Contact person:
Module responsibility:
- Frank Köster
- Die im Modul Lehrenden

Authorized examiners:
- Frank Köster
- Die im Modul Lehrenden

Entry requirements:

Skills to be acquired in this module:
This module introduces the principles of automated driving.

Professional competences:
The students:
- Discuss different levels of automated driving (eg. SAE-Level) and the differences
- Discuss different levels of connected driving and the differences
- Discuss core-domains of automated vehicles
- Discuss important technological pillars in the areas sense, plan, and act
- Discuss transition between different levels of automation
- Discuss the impact of connected vehicle functions on automated driving
- Discuss the impact of automated vehicle functions on connected driving
- Characterise the impact of automated and connected driving on road traffic
- Characterise the interaction of humans and automated and connected vehicles
- Design an abstract procedure for the change of different levels of automation
- Design a rough vehicle architecture for automated and connected driving

Methodological competences:
The students:
- Analyze complex automated and connected vehicles (-> domains)
- Analyze core-functions of automated and connected vehicles (-> functions)

Social competences:
The students:
- Work in teams
- Discuss their outcomes appropriately

Self-competences:
The students:
- Acknowledge the limits of their ability to cope with pressure during the analysis of complex (automated and connected) socio-technical systems

Module contents:
- levels of automated driving (eg. SAE-Level)
- levels of connected driving
- core-domains of automated vehicles
- sense, plan, and act in the context of automated and connected vehicles
- transition between different levels of automation
- selected connected vehicle functions
- selected automated vehicle functions
- human factors and socio-technical systems
- vehicle architectures
Reader's advisory

Suggested reading:


Links

Language of instruction  English
Duration (semesters)    1 Semester
Module frequency        Once a year
Module capacity         unlimited
Modullevel              AS (Akzentsetzung / Accentuation)
Modulart                Pflicht o. Wahlpflicht / compulsory or optional
Lern-/Lehrform / Type of program  V+Ü

Vorkenntnisse / Previous knowledge
inf201 Technische Informatik, inf203 Eingebettete Systeme I, inf204 Eingebettete Systeme II

Examination

Time of examination
Type of examination

Final exam of module

At the end of the lecture period
Praktical work and oral exam

Course type  Comment  SWS  Frequency  Workload attendance

Lecture  2.00  SuSe  28 h
Exercises  2.00  SuSe  28 h

Total time of attendance for the module  56 h
inf332 - Practice Robotics

Module label: Practice Robotics
Module code: inf332
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction

Contact person:
Module responsibility:
- Andreas Hein
- Die im Modul Lehrenden

Authorized examiners:
- Die im Modul Lehrenden
- Andreas Hein

Entry requirements:

Skills to be acquired in this module:

Professional competences:
The students learn:
- Programming of robots (mobile or stationary)
- Implementation of elementary operations
- Integration of operations into a small application scenario
- Programming using Robot Operating System (ROS)

Methodological competences:
The students learn:
- Systematic development process with team members
- Systematic evaluation of the application
- Designing a robotic application using basic and advanced robotic concepts

Social competences:
The students learn:
- Project management
- Team work
- Organization of the team

Self-competences:
The students:
- Time management
- Autodidactic work (literature search, technical specs, related work)

Module contents:
Robotic systems will be provided to the students. They will then define the project/application scenario of the robots by their own and complete the project as a small team with self-organization and work distribution among the team members.
The module consists of a lecture and an exercise part:
Lecture: 2-3 lectures for introduction onto the module and introduction into the Robot Operating System (ROS) as well as the concepts of the projects.
Exercises: After the introduction period, the students will work self-organized to complete the proposed project. Work can be distributed weekly or on as concentrated time blocks.

Reader's advisory:
John J. Craig, Introduction to Robotics: Mechanics and Control
Patrick Goebel, ROS By Example

Links:

Language of instruction: English
Duration (semesters): 1 Semester
Module frequency: Once a year
Module capacity: unlimited
Modulelevel: AS (Akzentsetzung / Accentuation)
Modulart: Pflicht o. Wahlpflicht / compulsory or optional
Lern-/Lehrform / Type of program: V+Ü

Vorkenntnisse / Previous knowledge:

Examination:
Time of examination: At the end of the lecture period
Type of examination: Demonstration and written documentation
Course type: Comment: SWS
Frequency: Workload attendance

81 / 174
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**Total time of attendance for the module**  56 h
inf333 - Sensor Technology in the Automotive Domain

Module label: Sensor Technology in the Automotive Domain
Module code: inf333
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- 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

Contact person:
Module responsibility:
- Frank Köster
- Die im Modul Lehrenden

Authorized examiners:
- Die im Modul Lehrenden
- Frank Köster

Entry requirements:
Skills to be acquired in this module:

Professional competences:
The students:
- Discuss different levels of sensor-technologies
- Discuss sensor-data fusion (multi-level fusion)
- Discuss Kalman-Filter
- Discuss in-vehicle data-processing
- Discuss Car2Cx-technologies
- Design simple multi-sensor systems
- Evaluate multi-sensor systems

Methodological competences:
The students:
- Analyze multi-sensor systems
- Design multi-sensor systems
- Evaluate multi-sensor systems

Social competences:
The students:
- Work in teams
- Discuss their outcomes appropriately

Self-competences:
The students:
- Acknowledge the limits of their ability to cope with pressure during the work on the topics of the module

Module contents:
- Sensor-technologies
- Data fusion (multi-level fusion)
- Kalman-Filter
- In-vehicle data-processing
- Car2Cx-technologies (ITS G5 and 5G)
- Multi-sensor and multi-level fusion architectures

Reader's advisory:
Suggested reading:
### Links


### Language of instruction

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### Duration (semesters)

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### Lern-/Lehrform / Type of program

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### Previous knowledge

**Vorkenntnisse / Previous knowledge**

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inf334 - System Level Design

Module label: System Level Design
Module code: inf334
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- 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

Contact person:
Module responsibility:
- Kim Grüttner
Authorized examiners:
- Die im Modul Lehrenden

Authorized examiners:
- Die im Modul Lehrenden
- Kim Grüttner

Entry requirements:

Skills to be acquired in this module:

Professional competences:
The students:
- Ability to describe and analyze system components and architectures using system level description languages SpecC and SystemC
- Capabilities for partitioning and parallelizing of applications

Methodological competences:
The students:
- Knowledge of refinement and transformation techniques for transferring an initial specification into a real implementation
- Knowledge of the phases of a system-level design flow
- Knowledge of current design methods and tools in system level design
- Knowledge about formal models of computation languages
- Knowledge of current research results and trends in system level design
- Capabilities for partitioning and parallelizing of applications
- Ability to evaluate and explore design decisions
- Ability to implement a complete system design-to-implementation specification

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

Self-competences:
The students:
- presentation skills
- reflect their solutions by using methods learned in this course

Module contents:
The ever-increasing integration densities of integrated circuits enable the implementation of increasingly powerful and complex systems. This can be on the one hand the integration of several sub-components on the same chip (system-on-chip) or on the other hand the implementation of more powerful algorithms. However, traditional design techniques are hardly able to cope with the increasing complexity of today’s embedded systems. Therefore, in research and practice efforts through new methods and tools, there is a significant increase in productivity in the design process, thus closing the so-called “design productivity gap”. This is achieved, for example, by a stronger abstraction, in which the behavior of components is described only at the algorithmic level and is automatically translated into hardware or software implementations by high-level synthesis techniques. The final system implementation is achieved by means of a structured refinement and exploration processes. Throughout this refinement flow, system properties (for example, timing, energy consumption, chip area and costs) are estimated on each abstraction level and guide the designer in the iterative decision process. By means of techniques such as virtual prototyping, entire systems can be simulated and verified on each refinement layer, even without the availability of a full implementation for all system components.
This module builds on the modules Embedded Systems I and II, deepens the knowledge acquired there for the design of hardware/software systems and expands them with current methods and tools. With SystemC, a language is presented that is already widely used in industry and research for the design and verification of hardware/software systems and supports several abstraction levels from clock cycle accurate hardware description, over transaction level models to process based functional specifications.

### Suggested reading:

**Main textbooks:**

**Optional books:**

Additional reading material posted on Stud.IP

### Language of instruction
- English

### Duration (semesters)
- 1 Semester

### Module frequency
- once a year

### Module capacity
- unlimited

### Module level
- AS (Akzentsetzung / Accentuation)

### Lern-/Lehrform / Type of program
- V+Ü

### Examination
- Final exam of module: at the end of the lecture period, hands-on exercises and oral exam

### Course type

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### Total time of attendance for the module
- 56 h
inf335 - Strategy Synthesis

Module label: Strategy Synthesis
Module code: inf335
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction

Contact person:
Module responsibility
- Die im Modul Lehrenden

Authorized examiners
- Die im Modul Lehrenden

Entry requirements:
The students learn fundamental techniques in strategy synthesis as foundation for high-level control strategies in highly autonomous systems

Skills to be acquired in this module

Professional competences:
The students:
- understand the concepts of open, reactive systems and can explain their relevance
- can provide formal model of open reactive systems and their relevance for system design
- understand the concept of world models as internal representation of a systems environment
- understand and can explain the concept of strategies, and relate this to system design
- understand the relevance of information flow in distributed system
- understand the relevance of choosing the periphery of world models
- can formalize system requirements in temporal logic
- understand the relevance of assumptions in system design

Methodological competences:
The students:
- methods for synthesis of winning strategies in closed systems
- methods for synthesizing remorse-free strategies in open systems
- methods for determining the perimeter of world models
- methods for cooperative strategy synthesis

Social competences:
The students:
- Work in teams
- Solve complex modelling, design, and synthesis tasks in teams

Self-competences:
The students:
- Reflect their actions and respect the scope of methods for strategy synthesis

Module contents:
The module gives an introduction to the synthesis of control strategies for highly autonomous systems. We first introduce classical game theory and present algorithms for synthesizing strategies for reactive system. We extend this to open systems, and analyze conditions, under which synthesis for distributed systems is decidable. We introduce remorse-free strategies and present compositional approaches to synthesis of remorse-free strategies. We analyze under what conditions world models allow for optimal remorse free strategies. We provide algorithms for computing weakest assumptions on the system environments under which winning strategies exist. We extend this to cooperative strategy synthesis, where multiple players cooperate in achieving jointly the system objectives. We illustrate these concepts with examples from autonomous driving.

Reader's advisory:
Suggested reading:
- Werner Damm and Bernd Finkbeiner. Automatic compositional synthesis of distributed systems. In Cliff Jones, Pekka Pihlajasaraari, and Jun Sun, editors, FM 2014: Formal Methods, volume 8442 of Lecture


**Links**

<table>
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inf336 - Application Area Automotive

Module label  Application Area Automotive

Module code  inf336

Credit points  6.0 KP

Workload  180 h

Used in course of study
- 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

Contact person
Module responsibility
- Frank Köster
- Die im Modul Lehrenden

Authorized examiners
- Die im Modul Lehrenden
- Frank Köster

Entry requirements
Skills to be acquired in this module
This module introduces the application area Automotive.

Professional competences: The students:
- Discuss core-concepts of the transportation domain
- Discuss different modes of transportation (focus on the automotive sector)
- Discuss automated and connected driving (short introduction/overview)
- Discuss human factors in the automotive sector
- Discuss traffic infrastructure (focus on intersections)
- Discuss basic principles in traffic management

Methodological competences: The students:
- Analyze vehicle systems
- Analyze traffic infrastructure
- Analyze cooperative vehicle/infrastructure systems
- Analyze socio-technical systems

Social competences: The students:
- Work in teams
- Discuss their outcomes appropriately

Self-competences: The students:
- Acknowledge the limits of their ability to cope with pressure during the work on the topics of the module

Module contents
- Core-concepts of the transportation domain
- Modes of transportation (focus on the automotive sector)
- Automated and connected driving (short introduction/overview)
- Human factors in the automotive sector
- Traffic infrastructure (focus on intersections)
- Basic principles in traffic management

Reader's advisory

Links
Language of instruction  English

Duration (semesters)  1 Semester

Module frequency  once a year

Module capacity  unlimited

Module level  AS (Akzentsetzung / Accentuation)

Module level  ---

Moduleart  Pflicht o. Wahlpflicht / compulsory or optional

Moduleart  je nach Studiengang Pflicht oder Wahlpflicht

Lern-/Lehrform / Type of program  V+Ü

Vorkenntnisse / Previous knowledge

Examination

Time of examination  At the end of the lecture period

Type of examination  Practical Work and oral Exam

Final exam of module

Course type  Comment  SWS  Frequency  Workload attendance
Lecture  2.00  SuSe  28 h
Exercises  2.00  SuSe  28 h

Total time of attendance for the module  56 h
inf338 - Design of Autonomous Systems

Module label: Design of Autonomous Systems

Module code: inf338

Credit points: 6.0 KP

Workload: 180 h

Used in course of study:
- 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

Contact person:
- Module responsibility:
  - Martin Georg Fränzle
- Authorized examiners:
  - Die im Modul Lehrenden
  - Martin Georg Fränzle

Entry requirements:

Skills to be acquired in this module:

Professional competences:
The students are enabled to analyze and build autonomous systems.

Methodological competences:
The students know examples of existing autonomous systems, understand the elements involved in their architectural design and the rationale behind decomposing the problem into obligations for the respective system components. The module furthermore enables the students to analyze existing architectures for autonomous systems with respect to their performance and safety. The students learn how to decompose a problem of designing an autonomous system into an architecture, are able to derive design obligations for its components, and can structure a pertinent safety case. They understand the software and hardware components necessary for achieving system autonomy and are able to design or instantiate these.

Social competences:
The students acquire hands-on experience in designing components for autonomous systems in small teams and present the underlying theory, their particular design decisions, and their personal evaluation to fellow students.

Self-competences:
The students can judge adequacy of their methodological skills for designing particular autonomous solutions. They are able to assess the safety impact of such a solution and are therefore able to develop a personal ethical stance towards its realization.

Module contents:
The module consists of a lecture and an exercise part

Reader's advisory:

Links:

Language of instruction: English

Duration (semesters): 1 Semester

Module frequency: once a year

Module capacity: unlimited

Modullevel: AS (Akzentsetzung / Accentuation)

Modulart: Pflicht o. Wahlpflicht / compulsory or optioal

Lern-Lehrform / Type of program: V+Ü

Vorkenntnisse / Previous knowledge:

Examination:

Time of examination: Second half of semester

Type of examination: Presentation

Final exam of module:

Course type | Comment | SWS | Frequency | Workload attendance
---|---|---|---|---
Lecture | | 2.00 | SuSe or WiSe | 28 h
Exercises | | 2.00 | SuSe or WiSe | 28 h

Total time of attendance for the module: 56 h
inf456 - Real-Time Systems

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Used in course of study
- Master's Programme Computing Science (Master) > Theoretische Informatik
- Master's Programme Embedded Systems and Microrobots (Master) > Akzentsetzungsmodul
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Contact person
- Module responsibility
  - Ernst-Rüdiger Olderog
  - Die im Modul Lehrenden

Authorized examiners
- Die im Modul Lehrenden
- Ernst-Rüdiger Olderog

Entry requirements

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 UPPAAAL 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 UPPAAAL,
• transformation of Duration Calculus for discrete time into regular languages
• implementability of real-time systems on PLC-like hardware

Reader's advisory

essential:


recommended:


Links

Languages of instruction  German, English
Duration (semesters)  1 Semester
Module frequency  irregular
Module capacity  unlimited
Modulelevel  AS (Akzentsetzung / Accentuation)
Modulart  Pflicht o. Wahlpflicht / compulsory or optional
Lern-/Lehrform / Type of program  V+Ü
Vorkenntnisse / Previous knowledge  Theoretische Informatik I + II
Examination  Time of examination  Type of examination
Final exam of module  At the end of the lecture period  Exercises and written or oral exam
Course type  Comment  SWS  Frequency  Workload attendance
Lecture  3.00  SuSe or WiSe  42 h
Exercises  1.00  SuSe or WiSe  14 h
Total time of attendance for the module  56 h
inf460 - Security

Module label | Security
---|---
Module code | inf460
Credit points | 3.0 KP
Workload | 90 h

Used in course of study
- 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

Contact person
Module responsibility
- Sibylle Fröschle
- Die im Modul Lehrenden

Authorized examiners
- Die im Modul Lehrenden
- Sibylle Fröschle

Entry requirements
Skills to be acquired in this module
The goal of this module is to provide a foundation in computer and network security.

**Professional competences:**
The students: - are aware of the threats posed by cyber attacks to computer and network systems - understand the basic principles and mechanisms to protect a system against these threats - are able to apply this knowledge to assess the risk of cyber attacks to a given system as well as to develop and evaluate countermeasures against them

**Methodological competences:**
The students: - carry out a threat and risk assessment - formulate security requirements for a given system - identify and apply standard security solutions to meet them (These are examples, the exact skills depend on the focus chosen by the student.)

**Social competences:**
The students: - are able to master a new topic by self-study and interaction with experts and peers - are able to explain principles and applications of computer security to experts and non-experts - are able to expertly discuss security risks and incidents

**Self-competences:**
The students: - follow up and critically assess current developments in computer security including security incidents - are security aware in their own behaviour, in their assessment of the systems they work with, and those they develop

Module contents
This module provides a broad and comprehensive knowledge in computer security. The topics cover threat analysis and attack trees, essential cryptographic tools, user authentication, access control, malware, intrusion detection and prevention, denial-of-service attacks and defences, software security and trusted systems, and network security. Students without prior knowledge in computer security focus on basic principles such as listed above. Students with prior knowledge in computer security can deepen their knowledge by studying real-world examples such as the SSL/TLS protocol. Typically, they will illustrate their topic by discussing a security incident reported in the public domain security news.

Reader's advisory

Links
- access from http://vhome.offis.de/sibylef

Language of instruction | English
Duration (semesters) | 1 Semester
Module frequency | once a year
Module capacity | unlimited
Reference text | Associated with the module(s): Security of Cyber-Physical Systems
Modullevel | AS (Akzentsetzung / Accentuation)
Modulart | MM (Mastermodul / Master module)
Lern-/Lehrform / Type of program | S or V
Vorkenntnisse / Previous knowledge | Basic knowledge in security
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inf522 - Information Processing in Bio-Medical Research

Module label: Information Processing in Bio-Medical Research

Module code: inf522

Credit points: 6.0 KP

Workload: 180 h

Used in course of study:
- Master's Programme Computing Science (Master) > Angewandte 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

Contact person:
Module responsibility:
- Rainer Röhrig

Authorized examiners:
- Die im Modul Lehrenden
- Rainer Röhrig

Entry requirements:

Skills to be acquired in this module:
The students are aware of the requirements of biomedical research information processing and technologies. They know, develop and evaluate approaches.

Professional competences:
The students:
- Know the principles of biomedical research and identify resulting requirements and develop appropriate solutions
- Know the regulatory guidelines and assess the suitability of (IT) solutions or develop them
- Plan, apply, evaluate, report and assess IT solution evaluation studies
- Are aware of the biomedical research responsibility and the ethical challenges

Methodological competences:
The students:
- Search literature systematically
- Plan and assess clinical studies
- Develop concepts for a data privacy and GCP conform study management
- Know and apply medical classification systems
- Validate and run software for clinical trials, cohorts and registries
- Plan and assess healthcare IT studies

Social competences:
The students:
- Present solutions/results
- Discuss studies constructively, professionally and appropriately
- Discuss ethical biomedical research problems from different points of view

Self-competences:
The students:
- Reflect their own values and attitudes in the context of medical and biomedical research border areas
- Reflect their self-capacity with regard to the responsibility and the workload during the implementation of studies and the operation of study information systems

Module contents:
- Basics / Biomedical research theory
- Systematic literature research, repositories
- Study schedule and method design
- Biomedical research regulatory framework
- Biomedical research ethics
- IT infrastructure in research / IT components incl. molecular medicine
- (Data) privacy
Operating of software for clinical trials, cohorts and registries
Clinical study report standards (Equator-Network), review process
Evaluation of healthcare IT (GEP-HI and STARE-HI) / evidence based healthcare informatics

<table>
<thead>
<tr>
<th>Reader's advisory</th>
<th>Wird im Modul bekannt gegeben</th>
</tr>
</thead>
</table>

### Links

- Languages of instruction: German, English
- Duration (semesters): 1 Semester
- Module frequency: once a year
- Module capacity: unlimited
- Module level: AS (Akzentsetzung / Accentuation)
- Modular: je nach Studiengang Pflicht oder Wahlpflicht
- Lern-/Lehrform / Type of program: V+Ü
- Vorkenntnisse / Previous knowledge: Medizin für Informatiker, Statistik
- Examination:
  - Time of examination: At the end of the lecture period
  - Type of examination: Written exam

### Final exam of module

<table>
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<tr>
<th>Course type</th>
<th>Comment</th>
<th>SWS</th>
<th>Frequency</th>
<th>Workload attendance</th>
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<td>Lecture</td>
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<tr>
<td>Exercises</td>
<td></td>
<td>2.00</td>
<td>SuSe</td>
<td>28 h</td>
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### Total time of attendance for the module

56 h
inf523 - Medical Software Engineering

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<td>Module code</td>
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<td>Workload</td>
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<td></td>
<td>Master's Programme Computing Science (Master) &gt; Angewandte Informatik</td>
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<tr>
<td></td>
<td>Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Embedded Brain Computer Interaction</td>
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<tr>
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<td>Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Human-Computer Interaction</td>
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<td></td>
<td>Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Systems Engineering</td>
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<td>Module responsibility</td>
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<td>Rainer Röhrig</td>
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<td>Rainer Röhrig</td>
</tr>
<tr>
<td>Entry requirements</td>
<td></td>
</tr>
<tr>
<td>Skills to be acquired in this module</td>
<td>This Module provides the regulatory requirements of medical software. Focus is on software life cycle methods and approaches, the implementation of combined usability- and risk management processes as well as quality management.</td>
</tr>
<tr>
<td>Professional competence</td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>Know and use obligatory medical software requirements</td>
</tr>
<tr>
<td></td>
<td>Know methods and approaches to develop security-critical medical software and implement them by example</td>
</tr>
<tr>
<td></td>
<td>Know at least one medical application area and its specific professional, organisational and regulatory requirements</td>
</tr>
<tr>
<td>Methodological competence</td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>Are able to apply risk management methods of socio-technical systems</td>
</tr>
<tr>
<td></td>
<td>Are able to extend their knowledge of new application areas. They are able to handle the obstacles of normative frameworks and software development.</td>
</tr>
<tr>
<td>Social competence</td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>Realise the importance of communication during the software development process between developer, customer and user of a successful and secure system. Feedback, request, respectful cooperation and empathy of other disciplines’ working processes are of great importance.</td>
</tr>
<tr>
<td>Self-competence</td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>Realise their responsibility as a computer scientist and reflect their impact on patients, medical employers and hospitals (corporates)</td>
</tr>
<tr>
<td>Module contents</td>
<td>Content of the Module:</td>
</tr>
<tr>
<td></td>
<td>This module provides medical software development processes. The module deals with normative software requirements with the focus on patient privacy and quality management. Contents are the declaration of conformity based on medical product classes and software security classes. The software security is focused on software quality, tests and verification, validation as well as quality and risk management. The software life cycle provides security related systems and software as well as software architecture and different process models.</td>
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<tr>
<td>Reader's advisory</td>
<td>wird im Modul bekannt gegeben</td>
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<tr>
<td>Languages of instruction</td>
<td>German, English</td>
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### Duration (semesters)
1 Semester

### Module frequency
once a year

### Module capacity
unlimited

### Module level
AS (Akzentsetzung / Accentuation)

### Module type
Pflicht o. Wahlpflicht / compulsory or optional

### Learning form / Type of program
V + Ü

### Previous knowledge
Medizin für Informatiker
Programmierkenntnisse / Softwareentwicklung / Informationssysteme / Mensch Maschine Interaktion

### Examination
- **Time of examination**: At the end of the lecture periods
- **Type of examination**: written exam

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<thead>
<tr>
<th>Final exam of module</th>
<th>At the end of the lecture periods</th>
<th>written exam</th>
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</thead>
<tbody>
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<tr>
<td>Exercises</td>
<td>2.00</td>
<td>WiSe</td>
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</table>

**Total time of attendance for the module**: 56 h
### Module Information

**Module label**: Computational Intelligence II

**Module code**: inf536

**Credit points**: 6.0 KP

**Workload**: 180 h

**Used in course of study**
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte 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 Environmental Modelling (Master) > Mastermodule

**Contact person**
- **Module responsibility**: Oliver Kramer
- **Authorized examiners**: Die im Modul Lehrenden
- Oliver Kramer

**Entry requirements**

**Skills to be acquired in this module**

**Professional competence**

The students:
- Recognise machine learning problems
- Implement simple algorithms of machine learning
- Critically discuss solutions and selection of methods
- Deepen previous knowledge of analysis and linear algebra

**Methodological competence**

The students:
- Deepen programming skills
- Apply modelling skills
- Learn about the relation between problem class and method selection

**Social competence**

The students:
- Cooperatively implement content introduced in lecture
- Evaluate own solutions and compare them with those of their peers

**Self-competence**

The students:
- Evaluate own skills w.r.t. peers
- Realise personal limitations
- Adapt own problem solving approaches w.r.t. required method competences

**Module contents**

Computational Intelligence comprises intelligent and adaptive methods for optimisation and learning. The module "Computational Intelligence II" concentrates on methods for machine learning and data mining. The exercises introduce and deepen practical aspects of the implementation and algorithmic design, also taking into account application aspects.

**Overview of Content**:
- Foundations of learning and classification
- Nearest neighbouring methods
- Model selection and parameter tuning
- Regression
- Support vector and kernel methods
- Clustering
- Dimensionality reduction
Readers advisory

- HASTIE, T., TIBSHIRANI, R., FRIEDMAN, J.H.: The Elements of Statistical Learning, Springer 2009

<table>
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<tr>
<th>Links</th>
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<td>Module capacity</td>
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<td>Modulart</td>
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<td>Lern-/Lehrform / Type of program</td>
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<th>Type of examination</th>
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<td>At the end of the semester</td>
<td>Written or oral exam</td>
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<th>Frequency</th>
<th>Workload attendance</th>
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<td>Exercises</td>
<td></td>
<td>2.00</td>
<td>SuSe</td>
<td>28 h</td>
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</table>

| Total time of attendance for the module | 56 h |
**inf537 - Intelligent Systems**

**Module label**  Intelligent Systems  
**Module code**  inf537  
**Credit points**  6.0 KP  
**Workload**  180 h  

**Used in course of study**  
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodul der Informatik  
- Master's Programme Computing Science (Master) > Angewandte 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

**Contact person**  
Module responsibility  
- Jürgen Sauer  
- Die im Modul Lehrenden  
Authorized examiners  
- Jürgen Sauer  
- Die im Modul Lehrenden

**Entry requirements**  
**Skills to be acquired in this module**  
- **Professional competence** The students:  
  - name the structure of agent-based systems  
  - use problem-solving methods for complex problems  
  - characterise the application area of process planning  
  - evaluate the suitability of processes regarding to specific problems  
- **Methodological competence** The students:  
  - assign problem-solving methods to different problems  
- **Social competence** The students:  
  - implement selected methods in small teams  
- **Self-competence** The students:  
  - develop own solutions for given problems

**Module contents**  
A lot of application areas use "intelligent" problem-solving methods. These are the main focus of this lecture. They will be illustrated by examples in order to enhance the students' problem-solving abilities. These include:  
- A brief introduction into AI  
- Agent systems and  
- Solution methods of AI like heuristics, meta-heuristics, soft computing methods. To apply and foster the contents of the lecture, an intelligent planning system is implemented in practical exercises.

**Reader's advisory**  
Suggested reading:  
- Ghallab/Nau/Traverso: Automated Planning, Morgan Kaufman, 2004

**Links**  
www.wi-ol.de

**Languages of instruction**  
German, English

**Duration (semesters)**  
1 Semester

**Module frequency**  
once a year

**Module capacity**  
unlimited

**Reference text**  
Dieses Modul ist im Rahmen der Projekte FiIF und FoL konzipiert worden

**Modullevel**  
AS (Akzentsetzung / Accentuation)

**Modulart**  
je nach Studiengang Pflicht oder Wahlpflicht

**Lern-/Lehrform / Type of program**  
V+Ü

**Vorkenntnisse / Previous knowledge**  
Produktionsorientierte Wirtschaftsinformatik

**Examination**  
Time of examination  
Type of examination

**Final exam of module**  
At the end of the lecture period  
Practical exercises and oral exam or practical exercises and written exam or portfolio

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<th>Comment</th>
<th>SWS</th>
<th>Frequency</th>
<th>Workload attendance</th>
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<td>28 h</td>
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<tr>
<td>Exercises</td>
<td></td>
<td>2.00</td>
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<td>28 h</td>
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**Total time of attendance for the module**  
56 h
inf650 - Transport Systems

Module label: Transport Systems
Module code: inf650
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte 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

Contact person:
- Module responsibility
  - Axel Hahn
  - Die im Modul Lehrenden
- Authorized examiners
  - Axel Hahn
  - Die im Modul Lehrenden

Entry requirements:

Skills to be acquired in this module:
Objective of the module/skills:
The Module Transport Systems deals with planning and controlling systems of internal and external company logistics as well as public transport. It provides basic knowledge and recent research topics. The focus is on a resource-oriented holistic view of company logistics as well as the planning of transport infrastructure. Furthermore, trends such as autonomous vehicles and intelligent transport systems are discussed.

Professional competence:
The students:
- name the basics of planning and controlling company logistics
- assess transport systems of companies
- name methods and approaches of computer-aided transport systems and classify them
- characterise software to plan complex logistics

Methodological competence:
The students:
- display topics and concepts of transport systems
- simulate transport and its systems with appropriate methods

Social competence:
The students:
- work in groups
- discuss their results appropriately

Self-competence:
The students:
- realise their limits while working on a project containing aspects of modelling and implementation
- question the presentation of their results

Module contents:
- Transport and logistics concepts
- Data acquisition of company logistics
- Planning- and simulation software for complex logistics- and transport processes
- Energy- and resource efficient transport systems
- Resource-oriented transport cost calculations (e.g. CO2, noise pollution)
- Planning models for transport infrastructure

Reader's advisory:
Suggested reading:

<table>
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<tr>
<th>Links</th>
<th><a href="http://wi-ol.de">http://wi-ol.de</a></th>
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<td>Dieses Modul ist im Rahmen der Projekte FiIF und FoL konzipiert worden</td>
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<td>je nach Studiengang Pflicht oder Wahlpflicht</td>
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<td>Lern-/Lehrform / Type of program</td>
<td>V+Ü</td>
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<td>Produktionsorientierte Wirtschaftsinformatik</td>
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<td>Exercises and written exam</td>
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<tr>
<td>Exercises</td>
<td></td>
<td>2.00</td>
<td>SuSe</td>
<td>28 h</td>
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Total time of attendance for the module 56 h
**inf973 - Psychological practicum fNIRS, EEG**

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<td>Credit points</td>
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<td>Workload</td>
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<td>- Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Embedded Brain Computer Interaction</td>
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<tr>
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<td>Module responsibility</td>
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<tr>
<td></td>
<td>- Jochem Rieger</td>
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<td>- Die im Modul Lehrenden</td>
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<td>- Jochem Rieger</td>
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<td>- Die im Modul Lehrenden</td>
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<td>Entry requirements</td>
<td>Skills to be acquired in this module</td>
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<tr>
<td></td>
<td>Professional competences:</td>
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<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>- will acquire Knowledge of planning, performing, and analysis of a neurocognitive study</td>
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<tr>
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<td>Methodological competences:</td>
</tr>
<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>- learn to arrange a scientific report</td>
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<tr>
<td></td>
<td>- be taught in the methods of psychophysiology, e.g. EEG, MEG, IMRI, or fNIRS</td>
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<tr>
<td></td>
<td>Social competences:</td>
</tr>
<tr>
<td></td>
<td>The students:</td>
</tr>
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<td></td>
<td>- will work within a team</td>
</tr>
<tr>
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<td>Self-competences:</td>
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<td></td>
<td>The students:</td>
</tr>
<tr>
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<td>- will have to apply time management</td>
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<tr>
<td>Module contents</td>
<td>The module consists of a practical part.</td>
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<tr>
<td></td>
<td>The students will obtain knowledge of literature search, comprehension of scientific texts. They will acquire skills in conducting experimental research.</td>
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<td>Language of instruction English</td>
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**inf974 - Human Computer Interaction and Brain Computer Interfacing**

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<th>Human Computer Interaction and Brain Computer Interfacing</th>
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<tr>
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<td>Credit points</td>
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<td>Workload</td>
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<td>Contact person</td>
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<td></td>
<td>☑ Jochem Rieger</td>
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<td>☑ Andreas Lüdtke</td>
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<td></td>
<td>☑ Die im Modul Lehrenden</td>
</tr>
</tbody>
</table>

**Entry requirements**

**Skills to be acquired in this module**

**Professional competences:**

The students:

- Human computer interaction (HCI) in its interdisciplinary requirements focusing on the perspective from neurocognitive psychology.
- Basic knowledge of Brain Computer Interfacing

**Methodological competences:**

The students:

- Will acquire basic knowledge of neuroimaging and data analysis techniques.
- Will acquire Methodological competences: required for deriving statistical models to link brain and cognition/behavior.
- Will acquire skills and knowledge to critically reflect basic science theories in naturalistic context.

**Social competences:**

**Self-competences:**

The students will have knowledge of common experimental designs, data acquisition, and analysis methods and will have an insight of how to chose appropriate methods for their specific experiment. They are able to design and run a simple HCI/BCI experiment.

**Module contents**

The module consists of a lecture and an exercise part:

**Lecture:**

- Background and concepts of cognitive psychology relevant for human computer interaction
- Sensation, perception, action
- Data acquisition and processing methods for brain computer interfacing.

**Reader's advisory**


**Links**

<table>
<thead>
<tr>
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<th>English</th>
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<tr>
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<td>Module capacity</td>
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<td>Reference text</td>
<td>The module will start every summer term with part 1. Part 2 will be offered in the winter term.</td>
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<td>Modullevel</td>
<td>AS (Akzentsetzung / Accentuation)</td>
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<td>Modulart</td>
<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
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<td>Lern-Lehrform / Type of program</td>
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<td>Examination</td>
<td>Time of examination</td>
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<td>At the end of the lecture period</td>
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<td>Theorie-Praxis-Seminare</td>
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**Total time of attendance for the module** 56 h
inf461 - Security of Cyber-Physical Systems

Module label: Security of Cyber-Physical Systems
Module code: inf461
Credit points: 3.0 KP
Workload: 90 h

Used in course of study:
- 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

Contact person:
Module responsibility:
- Sibylle Fröschle
- Die im Modul Lehrenden

Authorized examiners:
- Die im Modul Lehrenden
- Sibylle Fröschle

Entry requirements:
Skills to be acquired in this module:
**Professional competences:** The students:
- are aware of the threats posed by cyber attacks to cyber-physical systems
- understand security solutions specific to CPS
- know examples of security architectures of CPS
- are able to apply this knowledge to assess the risk of cyber attacks to a given CPS as well as to develop a conceptual systems security architecture for it

**Methodological competences:** The students:
- carry out a threat and risk assessment for a given CPS
- formulate security requirements for a given CPS
- develop a systems security architecture for a given CPS to meet them (These are examples, the exact skills depend on the focus chosen by the student.)

**Social competences:** The students:
- are able to master a new topic by self-study and interaction with experts and peers
- are able to explain the significance and facets of security for CPS to experts and non-experts
- are able to expertly discuss security risks and incidents of CPS

**Self-competences:** The students:
- follow up and critically assess current developments in the security of CPS including relevant security incidents
- are security aware and foster a security culture with respect to CPS and the resulting critical infrastructures

Module contents:
Embedded systems in the energy, transportation, and health domains are currently undergoing a technological transition towards highly networked automated cyber-physical systems (CPS). Such systems are potentially vulnerable to cyber attacks, and these can have physical impact. This includes targeted sabotage of a plant (e.g. Stuxnet), large-scale sabotage of infrastructure to cause economic damage (e.g. attacks against energy grids), and indiscriminate attacks to cause civilian casualties (e.g. by compromise of transportation systems). In this module we investigate and discuss security principles, solutions, and architectures for CPS as well as real-life security incidents. The topics include distance bounding protocols, location tracking and counter-measures, safety and security engineering of CPS, security in the automotive and maritime domain including car hacking and vehicle-2-x communication, hacking in the medical domain, attacks against energy grids, Stuxnet, CPS and society: benefits, risks, acceptance.

Reader's advisory:
Recent scientific papers and reports in the public domain news.

Links:
http://vhome.offis.de/sibyllef

Language of instruction:
English

Duration (semesters):
1 Semester

Module frequency:
one a year

Module capacity:
unlimited

Modullevel:
AS (Akzentsetzung / Accentuation)

Modullevel:
MM (Mastermodul / Master module)

Modulart:
Pflicht o. Wahlpflicht / compulsory or optional

Modulart:
je nach Studiengang Pflicht oder Wahlpflicht

Lern-/Lehrform / Type of program:
S or V

Lern-/Lehrform / Type of program:
S or V

Vorkenntnisse / Previous knowledge:
Examination:
Time of examination:
Presentation and written documentation, oral exam, or exam

Course type:
Course or seminar

SWS:
2.00

Frequency:
SuSe or WiSe
| Workload attendance | 28 h |
inf533 - Probabilistic Modelling I

Module label: Probabilistic Modelling I
Module code: inf533
Credit points: 3.0 KP
Workload: 90 h

Used in course of study:
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Embedded Systems and Microelectronics (Master) > Akzentsetzungsmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Contact person:
Module responsibility:
- Claus Möbus
Authorized examiners:
- Claus Möbus
- Die im Modul Lehrenden

Entry requirements:
Probabilistic Bayesian models are generated with special tools (e.g. BUGS, JAGS, STAN) or domain specific programming languages (WebPPL, PyMC3, …etc.). If they mimic cognitive processes of humans (e.g. pilots, drivers) or animals they could be used as cooperative assistance systems in technical or financial systems like cars, robots, or recommenders.

Professional competence
The students:
- learn to map problem to model classes to come up with practical solutions

Methodological competence
The students:
- acquire basic skills in the design, implementation, and identification of probabilistic models with Bayesian methods
- acquire knowledge about alternative non-Bayesian machine learning methods

Social competence
The students:
- learn to present and discuss probabilistic theories, methods, and models.

Self-competence
The students:
- reflect and evaluate chances and limitations of probabilistic approaches
- learn to deliberate on machine-learning alternatives

Module contents:
Theories, methods, and examples of Bayesian models with practical applications

Reader's advisory:
Recent eBooks, eTutorials

Links:
http://www.uni-oldenburg.de/en/computingscience/lcs/probabilistic-programming/

Languages of instruction:
German, English

Duration (semesters):
1 Semester

Module frequency:
jährlich

Module capacity:
unlimited

Reference text:
Associated with the module:
- inf534 Probabilistic Modelling II
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| **Course type** | Seminar |
| **SWS** | 2.00 |
| **Frequency** | WiSe |
| **Workload attendance** | 28 h |
inf534 - Probabilistic Modelling II

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<td>Workload</td>
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<td>Used in course of study</td>
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<td>- Master's Programme Computing Science (Master) &gt; Angewandte Informatik</td>
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<td>- Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodul</td>
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<td></td>
<td>- Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Embedded Brain Computer Interaction</td>
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<tr>
<td>Contact person</td>
<td>Module responsibility</td>
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<tr>
<td></td>
<td>- Claus Möbus</td>
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<td>- Die im Modul Lehrenden</td>
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<td>Authorized examiners</td>
<td>- Claus Möbus</td>
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<td></td>
<td>- Die im Modul Lehrenden</td>
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</table>

**Entry requirements**

**Skills to be acquired in this module**

- Probabilistic models are generated with special tools (e.g. BUGS, JAGS, STAN) or domain specific programming languages (WebPPL, PyMC3, etc.). If they mimic cognitive processes of humans (e.g. pilots, drivers) or animals they could be used as cooperative assistance systems in technical or financial systems like cars, robots, or recommenders. In this part of the seminar we read, present, and discuss recent research papers.

**Professional competence:**

The students:

- learn to connect problem- with model classes to come up with practical solutions

**Methodological competence**

The students:

- acquire advanced skills in the design, implementation, and identification of probabilistic models with Bayesian methods
- acquire knowledge about alternative machine learning methods

**Social competence**

The students:

- learn to present and discuss probabilistic theories, methods, and models

**Self-competence**

The students:

- reflect and evaluate chances and limitations of probabilistic approaches
- learn to deliberate on machine-learning alternatives

**Module contents**

Theories, methods, and examples of Bayesian models with practical applications

**Reader's advisory**

Recent publications

**Links**

http://www.uni-oldenburg.de/en/computingscience/lcs/probabilistic-programming/

**Language of instruction**

German

**Duration (semesters)**

1 Semester

**Module frequency**

halbjährlich

**Module capacity**

unlimited

**Reference text**

Associated with the module:

- inf533 Probabilistische Modellierung I
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<td>Frequency</td>
<td>SuSe</td>
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<tr>
<td>Workload attendance</td>
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**inf535 - Computational Intelligence I**

<table>
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<tbody>
<tr>
<td>Module code</td>
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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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</table>

**Used in course of study**
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte 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 Environmental Modelling (Master) > Mastermodule

**Contact person**
- Module responsibility
  - Oliver Kramer
  - Die im Modul Lehrenden
- Authorized examiners
  - Oliver Kramer
  - Die im Modul Lehrenden

**Entry requirements**

**Skills to be acquired in this module**

**Professional competence:**
The students:
- recognise optimisation problems
- implement simple algorithms of heuristic optimisation
- critically discuss solutions and selection of methods
- deepen previous knowledge of analysis and linear algebra

**Methodological competence**
The students:
- deepen programming skills
- apply modelling skills
- learn about the relation between problem class and method selection

**Social competence**
The students:
- cooperatively implement content introduced in lecture
- evaluate own solutions and compare them with those of their peers

**Self-competence**
The students:
- evaluate own skills with reference to peers
- realize personal limitations
- adapt own problem solving approaches with reference to required method competences

**Module contents**
Computational Intelligence comprises intelligent and adaptive methods for optimisation and learning. The module "Computational Intelligence I" concentrates on methods for evolutionary optimisation and heuristic approaches. The exercises introduce and deepen practical aspects of the implementation and algorithmic design, also taking into account application aspects.

**Overview of Content:**
- foundations of optimisation
- genetic algorithms and evolution strategies
- parameter control and self-adaptation
- runtime analysis
- swarm algorithms
- constrained optimisation
- multi-objective optimisation
- meta-modeling
Reader's advisory


Links

Languages of instruction: English, German

Duration (semesters): 1 Semester

Module frequency: jährlich

Module capacity: unlimited

Modullevel: AS (Akzentsetzung / Accentuation)

Modulart: je nach Studiengang Pflicht oder Wahlpflicht

Lern-/Lehrform / Type of program

Vorkenntnisse / Previous knowledge: Grundlagen der Statistik

Examination:
- Time of examination: At the end of the lecture period
- Type of examination: Written or oral exam

Course type:
- Lecture: SWS: 2.00, Frequency: WiSe, Workload attendance: 28 h
- Exercises: SWS: 2.00, Frequency: WiSe, Workload attendance: 28 h

Total time of attendance for the module: 56 h
inf663 - Application Area Maritime

Module label: Application Area Maritime
Module code: inf663
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- Master's Programme Computing Science (Master) > Angewandte 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

Contact person:
Module responsibility
- Axel Hahn
- Die im Modul Lehrenden

Authorized examiners:
- Axel Hahn
- Die im Modul Lehrenden

Entry requirements:

Skills to be acquired in this module:

Professional competences:
The students gain knowledge about ship handling and navigation and learn to understand maritime transportation as a system of systems with systems on board for stability, propulsion and steering as for bridge resource management. They understand the latter as a major contribution to organize navigation as a hierarchical team concept of a safety critical sociotechnical system. The students are aware of the special technical and physical challenges of navigation.

Methodological competences:
The students can apply system engineering methods to describe, analyse and design maritime systems. By looking on maritime transportation the gain transferable knowledge on other cyber physical systems. Students learned to how systems can deal with harsh environmental conditions in a resilient way.

Social competences:
Maritime transportation is a major basis of a global economy. Typically, students do not have an understanding of these transportation systems nor their technical and systemic challenges. Therefore, the student knows the concepts of maritime transportation and its role in international transportation networks after finishing this module.

Self-Competences:
Especially their competences cover an understanding as maritime transportation as a systems of system with high requirements on reliability, dependability and safety in combination with efficiency to be competitive in a global economy.

Module contents:
The module consists of a lecture and an exercise part:
Lecture: Maritime Transportation in global and local supply chains, Base concepts of ship handling and navigation, maritime system dynamics, bridge resource management, eNAvigation and high automation systems.
Seminar: Covering aspects of maritime transportation

Reader's advisory:
Bernhard Berking, Werner Huth (Herausgeber), Handbuch Nautik 1: Navigatorische Schiffsführung, Seehafen Verlag, 2010

Links:
Language of instruction: English
Duration (semesters): 1 Semester
Module frequency: Once a year
Module capacity: unlimited
Modulelevel: AS (Akzentsetzung / Accentuation)
Modulart: Pflicht o. Wahlpflicht / compulsory or optional
Lern-/Lehrform / Type of program: V+S

Vorkenntnisse / Previous knowledge:

Examination:
Time of examination: At the end of the lecture period
Type of examination: Oral exam and documentation

Final exam of module:
Course type: Lecture
Comment: SWS
Frequency: 2.00
Workload attendance: 28 h

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<table>
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<tr>
<th>Course type</th>
<th>Comment</th>
<th>SWS</th>
<th>Frequency</th>
<th>Workload attendance</th>
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<td>Seminar</td>
<td></td>
<td>2.00</td>
<td>SuSe and WiSe</td>
<td>28 h</td>
</tr>
</tbody>
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**Total time of attendance for the module**

56 h
### Module Contents

This module contains a lecture and practical exercises throughout the entire semester.

The following topics are covered: Synergies of maritime systems as well as their analysis and optimization. Treatment of the economic design and manufacture of maritime systems, stability calculations, ship dynamics, rules and guidelines, and the economic perspective for offshore platforms.

### Reader's Advisory


### Links

http://www.wi-ol.de

### Languages of instruction

German, English

### Duration (semesters)

1 Semester

### Module frequency

Annually in winter term

### Module capacity

Unlimited

### Modullevel

AS (Akzentsetzung / Accentuation)

### Modullevel

AS (Akzentsetzung / Accentuation)

### Modulart

Wahlmodul / Opportunity

### Modulart

Wahlmodul / Opportunity

### Lern-/Lehrform / Type of program

V+Ü

### Lern-/Lehrform / Type of program

V + Ü

### Vorkenntnisse / Previous knowledge

Transportsysteme, Analysis, Differentialgleichungen, lineare Algebra, Mechanik

### Vorkenntnisse / Previous knowledge

Transportsysteme, Analysis, Differentialgleichungen, lineare Algebra, Mechanik

### Examination

Type of examination:
- Time of examination: at the end of the lecture period
- Practical exercises and oral examination

### Final exam of module

- Lecture: 2.00 SWS, WiSe 28 h
- Exercises: 2.00 SWS, WiSe 28 h
<table>
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<th>SWS</th>
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<td></td>
<td></td>
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# Systems Engineering

**inf301 - Machine-oriented Systems Engineering**

<table>
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<tr>
<th>Module label</th>
<th>Machine-oriented Systems Engineering</th>
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<tbody>
<tr>
<td>Module code</td>
<td>inf301</td>
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<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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**Used in course of study**
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

**Contact person**
- Module responsibility
  - Alfred Mikschl
  - Die im Modul Lehren
- Authorized examiners
  - Alfred Mikschl
  - Die im Modul Lehren

**Entry 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

**Module contents**
- Embedded systems support complex feedback problems, control problems and data processing tasks. They have an important value creation potential for telecommunications, production management, transport and electronics. The functionality of embedded systems is realised by the integration of processors, special hardware and software. The embedded systems design is influenced by the heterogeneity of system architectures, the complexity of systems and technical and economic requirements.

This module gives an initial review of computer architectures. After that embedded systems are introduced by a specific microprocessor. Furthermore, external hardware will be connected to the microprocessor. Besides this, the design of circuit boards will be discussed. The students will design, develop and implement a circuit layout with CAD and programme this embedded system with a Flash-eprom.

**Reader's advisory**
- Lecturers notes, hardware manuals and data sheets, and development tool manuals

**Links**
- **Languages of instruction**
  - English, German
- **Duration (semesters)**
  - 1 Semester
- **Module frequency**
  - semi-annual
- **Module capacity**
  - unlimited
- **Modullevel**
  - AS (Akzentsetzung / Accentuation)
<table>
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<th>Modulart</th>
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<tr>
<td>Lern-Lehrform / Type of program</td>
<td>V+P</td>
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<td>Vorkenntnisse / Previous knowledge</td>
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<th>Type of examination</th>
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<tbody>
<tr>
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<td>At the end of the lecture period</td>
<td>Portfolio (Design, development and implementation of embedded systems, colloquium)</td>
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<th>Comment</th>
<th>SWS</th>
<th>Frequency</th>
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<td></td>
<td>2.00</td>
<td>WiSe</td>
<td>28 h</td>
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<td>Practical</td>
<td></td>
<td>2.00</td>
<td>WiSe</td>
<td>28 h</td>
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| Total time of attendance for the module | 56 h |
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

Reader's advisory

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

Recommended:

Secondary Literature:
- Altrock, M. O. R.: Fuzzy Logic, R. Oldenbourg Verlag, 1993
- Kahler, J. und Hubert, F.: Fuzzy-Logik und Fuzzy-Control, Vieweg, 1993
- Kratzer, K.P.: Neuronale Netze, Carl Hanser, 1993
- Lawrence, J.: Neuronale Netze, Syntagma Verlag, München, 1992
- Patterson, D.W.: Künstliche neuronale Netze, Prentice Hall, 1996
- Pham, D.T. a200
- Schulte, U.: Einführung in Fuzzy-Logik, Franzis-Verlag, München, 1993
- Zakharian, S. Ladowig-Riebler, P. und Thoer, St.: Neuronale Netze für Ingenieure, Vieweg, Wiesbaden, 1998
- Zimmermann H.-J. (Hrsg.): Datenanalyse, VDI-Verlag, 1995

Links

Languages of instruction
English, German

Duration (semesters)
1 Semester

Module frequency
once a year

Module capacity
unlimited

Modullevel
AS (Akzentsetzung / Accentuation)

Modulart
Pflicht o. Wahlpflicht / compulsory or optional

Lern-/Lehrform / Type of program
V+Ü

Vorkenntnisse / Previous knowledge
Regelungstechnik

Examination
Time of examination
Type of examination

Final exam of module
At the end of the lecture period until the beginning
Hands-on-exercises and oral Exam
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inf305 - Medical Technology

Module label  Medical Technology
Module code  inf305
Credit points  6.0 KP
Workload  180 h

Used in course of study
- Master's Programme Computing Science (Master) > Nicht Informatik
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Contact person
Module responsibility
- Andreas Hein

Authorized examiners
- Andreas Hein
- Die im Modul Lehrenden

Entry requirements
Skills to be acquired in this module
Professional competence
The students:
- Describe medical diagnosis and therapy methods
- Understand the core concepts of computer-assisted medical interventions
- Are aware of the basic concepts and legal conditions of the development of medical devices
- Define the character of medical devices' software parts and implement them
- Assess the complex interaction of medical products and patients
- Get familiar with the development of medical products within a short period of time

Methodological competence
The students:
- Recognise the interdisciplinary challenges and accordingly exchange information with other disciplines

Social competence
The students:
- Present solutions for specific questions

Self-competence
The students:
- reflect their solutions by using methods learned in this course

Module contents
- Medical areas and areas of application
- Basic requirements for medical systems (hygiene, MPG, technical security, materials)
- Medical systems:
  - Functional diagnostics (ECG, EMG, EEG)
  - Imaging systems (CT, MRI, ultrasound, PET, SPECT) - Therapy equipment (Laser, RF, Microtherapy)
  - Signal processing / monitoring (cardiovascular, hemodynamic, respiratory, metabolic, cerebral)
  - Medical Informatics (HIS, DICOM, Telemedicine, VR, image processing).

Reader's advisory
essential:
- Lecture slides

recommended:

**secondary literature:**


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inf307 - Robotics

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**Used in course of study**
- Master's Programme Computing Science (Master) > Nicht Informatik
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

**Contact person**
- Module responsibility
  - Andreas Hein
  - Die im Modul Lehrenden
- Authorized examiners
  - Die im Modul Lehrenden
  - Andreas Hein

**Entry 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- and ultrasonic-sensors
- Distance sensors (laser scanner, triangulation sensors)
- Force sensors
- Sensor data preparation

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

Actuators

Reader's advisory

essential:
lecture nodes

recommended:

sekondary literature:

Links
Languages of instruction
German, English

Duration (semesters)
1 Semester

Module frequency
once a year

Module capacity
unlimited

Module level
AS (Akzentsetzung / Accentuation)

Module type
Pflicht o. Wahlpflicht / compulsory or optional

Lern-/Lehrform / Type of program
V+Ü

Vorkenntnisse / Previous knowledge

Examination

Time of examination
At the end of the lecture period

Type of examination
Portfolio: Hands-on exercises, report, and written or oral exam

Final exam of module

Course type
Lecture
Exercises

Comment

SWS
3.00
1.00

Frequency
SuSe
SuSe

Workload attendance
42 h
14 h

Total time of attendance for the module
56 h
inf308 - Microrobotics II

Module label: Microrobotics II
Module code: inf308
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- Master's Programme Computing Science (Master) > Nicht Informatik
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering
- Master's Programme Engineering Physics (Master) > Schwerpunkt: Laser and Optics

Contact person
Module responsibility:
- Sergej Fatikow
- Die im Modul Lehrenden

Authorized examiners:
- Sergej Fatikow
- Die im Modul Lehrenden

Entry requirements

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

Reader’s advisory
- Lecture notes (can be obtained in secretariate, A1-3-303)

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

Module label: Low Energy System Design
Module code: inf311
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Contact person:
Module responsibility:
- Wolfgang Nebel
- Die im Modul Lehrenden

Authorized examiners:
- Die im Modul Lehrenden
- Wolfgang Nebel

Entry requirements:
This module introduces the estimation of power dissipation and optimisation.

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.

Reader’s advisory:
- Designing CMOS Circuits for Low Power – Dimitros Soudris, Christian Piguet, Costas Goutis
- Low-Power CMOS VLSI Circuit Design – Kaushik Roy, Sharat C. Prasad
- Low-Power Electronics Design – Christian Piguet et al.
- Leakage in Nanometer CMOS Technologies – Siva G. Narendra, Anantha Chandrakasan
- Entwurf von digitalen Schaltungen und Systemen mit HDLs und FPGAs – F. Kesel, R. Bartholomä
- Slides of the module „Eingebettete Systeme I+II“ von Professor Dr.-Ing. Wolfgang Nebel
- Slides and technical readouts of the used hardware and development tools

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inf333 - Sensor Technology in the Automotive Domain

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Used in course of study
- 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

Contact person

Module responsibility
- Frank Köster
- Die im Modul Lehrenden

Authorized examiners
- Die im Modul Lehrenden
- Frank Köster

Entry requirements

Skills to be acquired in this module
This module introduces the principles of sensors and sensor-systems as well as data-fusion in the automotive domain.

Professional competences:
The students:
- Discuss different levels/diverse levels sensor-technologies
- Discuss sensor-data fusion (multi-level fusion)
- Discuss Kalman-Filter
- Discuss in-vehicle data-processing
- Discuss car2cx-technologies
- Design simple multi-sensor systems
- Evaluate multi-sensor systems

Methodological competences:
The students:
- Analyze multi-sensor systems
- Design multi-sensor systems
- Evaluate multi-sensor systems

Social competences:
The students:
- Work in teams
- Discuss their outcomes appropriately

Self-competences:
The students:
- Acknowledge the limits of their ability to cope with pressure during the work on the topics of the module

Module contents

- Sensor-technologies
- Data fusion (multi-level fusion)
- Kalman-Filter
- In-vehicle data-processing
- Car2cx-technologies (ITS G5 and 5G)
- Multi-sensor and multi-level fusion architectures

Reader's advisory

Suggested reading:

Links

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Vorkenntnisse / Previous knowledge

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Total time of attendance for the module 56 h
**inf334 - System Level Design**

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**Used in course of study**
- 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

**Contact person**

**Module responsibility**
- Kim Grüttner
- Die im Modul Lehrenden

**Authorized examiners**
- Die im Modul Lehrenden
- Kim Grüttner

**Entry requirements**

**Skills to be acquired in this module**

**Professional competences:**
The students:
- Ability to describe and analyze system components and architectures using system level description languages SpecC and SystemC
- Capabilities for partitioning and parallelizing of applications

**Methodological competences:**
The students:
- Knowledge of refinement and transformation techniques for transferring an initial specification into a real implementation
- Knowledge of the phases of a system-level design flow
- Knowledge of current design methods and tools for system level design
- Knowledge about formal models of computation for specification languages
- Knowledge of current research results and trends in system level design
- Capabilities for partitioning and parallelizing of applications
- Ability to evaluate and explore design decisions
- Ability to implement a complete system design-to-implementation specification

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

**Self-competences:**
The students:
- Presentation skills
- Reflect their solutions by using methods learned in this course

**Module contents**
The ever-increasing integration densities of integrated circuits enable the implementation of increasingly powerful and complex systems. This can be on the one hand the integration of several sub-components on the same chip (system-on-chip) or on the other hand the implementation of more powerful algorithms. However, traditional design techniques are hardly able to cope with the increasing complexity of today's embedded systems. Therefore, in research and practice efforts through new methods and tools, there is a significant increase in productivity in the design process, thus closing the so-called "design productivity gap". This is achieved, for example, by a stronger abstraction, in which the behavior of components is described only at the algorithmic level and is automatically translated into hardware or software implementations by high-level synthesis techniques. The final system implementation is achieved by means of a structured refinement and exploration processes. Throughout this refinement flow, system properties (for example, timing, energy consumption, chip area and costs) are estimated on each abstraction level and guide the designer in the iterative decision process. By means of techniques such as virtual prototyping, entire systems can be simulated and verified on each refinement layer, even without the availability of a full implementation for all system components.
This module builds on the modules Embedded Systems I and II, deepens the knowledge acquired there for the design of hardware/software systems and expands them with current methods and tools. With SystemC, a language is presented that is already widely used in industry and research for the design and verification of hardware/software systems and supports several abstraction levels from clock cycle accurate hardware description, over transaction level models to process based functional specifications.

Reader's advisory

Suggested reading:

Main textbooks:


Optional books:


Additional reading material posted on Stud.IP

Links

https://www.uni-oldenburg.de/informatik/ehs/lehre/vorlesungen/system-level-design/

Language of instruction

English

Duration (semesters)

1 Semester

Module frequency

once a year

Module capacity

unlimited

Modullevel

AS (Akzentsetzung / Accentuation)

Modular

Pflicht o. Wahlpflicht / compulsory or optional

Lern-Lehrform / Type of program

V+Ü

Vorkenntnisse / Previous knowledge

Examination

Time of examination

Type of examination

Final exam of module

at the end of the lecture period

hands-on exercises and oral exam

Course type

Comment

SWS

Frequency

Workload attendance

Lecture

2.00

SuSe

28 h

Exercises

2.00

SuSe

28 h

Total time of attendance for the module

56 h
inf336 - Application Area Automotive

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**Contact person**

- Module responsibility
  - Frank Köster
  - Die im Modul Lehrenden
- Authorized examiners
  - Die im Modul Lehrenden
  - Frank Köster

**Entry requirements**

- This module introduces the application area Automotive.

**Skills to be acquired in this module**

- Professional competences: The students:
  - Discuss core-concepts of the transportation domain
  - Discuss different modes of transportation (focus on the automotive sector)
  - Discuss automated and connected driving (short introduction/overview)
  - Discuss human factors in the automotive sector
  - Discuss traffic infrastructure (focus on intersections)
  - Discuss basic principles in traffic management

- Methodological competences: The students:
  - Analyze vehicle systems
  - Analyze traffic infrastructure
  - Analyze cooperative vehicle/infrastructure systems
  - Analyze socio-technical systems

- Social competences: The students:
  - Work in teams
  - Discuss their outcomes appropriately

**Module contents**

- Core-concepts of the transportation domain
- Modes of transportation (focus on the automotive sector)
- Automated and connected driving (short introduction/overview)
- Human factors in the automotive sector
- Traffic infrastructure (focus on intersections)
- Basic principles in traffic management

**Reader's advisory**


**Links**

**Language of instruction**

- English

**Duration (semesters)**

- 1 Semester

**Module frequency**

- once a year

**Module capacity**

- unlimited

**Modullevel**

- AS (Akzentsetzung / Accentuation)

**Modulart**

- Pflicht o. Wahlpflicht / compulsory or optional

**Lern-/Lehrform / Type of program**

- V+Ü

**Vorkenntnisse / Previous knowledge**

**Examination**

<table>
<thead>
<tr>
<th>Time of examination</th>
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**Final exam of module**

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inf454 - Communicating and Mobile Systems

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

Used in course of study:
- Master's Programme Computing Science (Master) > Theoretische Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Contact person:
Module responsibility:
- Ernst-Rüdiger Olderog
- Die im Modul Lehrenden

Authorized examiners:
- Die im Modul Lehrenden
- Ernst-Rüdiger Olderog

Entry requirements:
Introduction to Milner's Calculus of Communicating Systems (CCS) and the ?-Calculus.

Skills to be acquired in this module:

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

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

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

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

Module contents:
Communication is one of the basic concepts of computer science. It occurs between computers in a network as well as between components of a computer. The focus of the course is on Robin Milner's ?-calculus. It enables a new modelling of communication, taking the location of the communication into account.

The ?-calculus can describe the change of data in a computer as well as the sending of messages or even programs along networks like the internet. It is also possible to describe reconfigurable networks. This will be shown using the examples of mobile phones, schedulers, automatic vending machines, data structures, communication protocols, and objects in object-oriented programming. All these applications are backed by the theory of the ?-calculus, which is based on operational semantics and a concept of behavioural equivalence. The theory will be explained in a step-by-step manner.

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

**Reader's advisory**


**Links**

http://csd.informatik.uni-oldenburg.de/

**Languages of instruction**

German, English

**Duration (semesters)**

1 Semester

**Module frequency**

irregular

**Module capacity**

unlimited

**Modullevel**

AS (Akzentsetzung / Accentuation)

**Modulart**

Pflicht o. Wahlpflicht / compulsory or optional

**Lern-/Lehrform / Type of program**

V+Ü

**Vorkenntnisse / Previous knowledge**

Theoretische Informatik II

**Final exam of module**

At the end of the lecture period written exam or oral exam

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**Total time of attendance for the module**

56 h
Real-Time Systems

Module label
Real-Time Systems

Module code
inf456

Credit points
6.0 KP

Workload
180 h

Used in course of study
- Master's Programme Computing Science (Master) > Theoretische Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Contact person
Module responsibility
- Ernst-Rüdiger Olderog
- Die im Modul Lehrenden

Authorized examiners
- Die im Modul Lehrenden
- Ernst-Rüdiger Olderog

Entry requirements
Introduction to formal methods of the specification and verification of time sensitive systems and their combinations.

Skills to be acquired in this module

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

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

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

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

Module contents
Examples of time-critical systems are railway control systems, robots, or even gas burners. It is essential for these systems to comply with certain timing conditions. For example, the control of a railway crossing must close the gates not later than 4 seconds after the sensors have reported an approaching train. If the gates are open, they should stay that way for at least 15 seconds to allow for a safe crossing of vehicles. Different specification methods have been developed to describe such timing conditions.

The Duration Calculus developed by Zhou Chaochen in 1991 is one attractive method. It is a logic combined with a calculus, in which the duration of states can be described. The course will introduce the Duration Calculus and will explain its application by means of examples. As further specification method Timed Automata introduced by Alur & Dill in 1994 will be presented. After the specification of real-time system requirements the verification of programs implementing these requirements will follow. The specification methods of the Duration Calculus and Timed Automata are used to describe the real-time behaviour of these programs. The correctness is then proven on the basis of these behavioral descriptions.

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

Reader's advisory
esential:


recommended:


Links

Languages of instruction
German, English

Duration (semesters)
1 Semester

Module frequency
irregular

Module capacity
unlimited

Module level
AS (Akzentsetzung / Accentuation)

Module type
Pflicht o. Wahlpflicht / compulsory or optional

Lern-/Lehrform / Type of program
V+Ü

Vorkenntnisse / Previous knowledge
Theoretische Informatik I – II

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

Course type
Comment
SWS
Frequency
Workload attendance
Lecture
3.00
SuSe or WiSe
42 h
Exercises
1.00
SuSe or WiSe
14 h

Total time of attendance for the module
56 h
inf460 - Security

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**Used in course of study**
- 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

**Contact person**
- Module responsibility
  - Sibylle Fröschle
  - Die im Modul Lehrenden
- Authorized examiners
  - Die im Modul Lehrenden
  - Sibylle Fröschle

**Entry requirements**

**Skills to be acquired in this module**

The goal of this module is to provide a foundation in computer and network security.

**Professional competences:**
The students: 
- are aware of the threats posed by cyber attacks to computer and network systems - understand the basic principles and mechanisms to protect a system against these threats - are able to apply this knowledge to assess the risk of cyber attacks to a given system as well as to develop and evaluate countermeasures against them

**Methodological competences:**
The students: 
- carry out a threat and risk assessment - formulate security requirements for a given system - identify and apply standard security solutions to meet them (These are examples, the exact skills depend on the focus chosen by the student.)

**Social competences:**
The students: 
- are able to master a new topic by self-study and interaction with experts and peers - are able to explain principles and applications of computer security to experts and non-experts - are able to expertly discuss security risks and incidents

**Self-competences:**
The students: 
- follow up and critically assess current developments in computer security including security incidents - are security aware in their own behaviour, in their assessment of the systems they work with, and those they develop

**Module contents**

This module provides a broad and comprehensive knowledge in computer security. The topics cover threat analysis and attack trees, essential cryptographic tools, user authentication, access control, malware, intrusion detection and prevention, denial-of-service attacks and defences, software security and trusted systems, and network security. Students without prior knowledge in computer security focus on basic principles such as listed above. Students with prior knowledge in computer security can deepen their knowledge by studying real-world examples such as the SSL/TLS protocol. Typically, they will illustrate their topic by discussing a security incident reported in the public domain security news.

**Reader's advisory**

**Links**
- access from http://vhome.ofis.de/sibylief

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**Reference text**

Associated with the module(s): Security of Cyber-Physical Systems

**Modullevel**

AS (Akzentsetzung / Accentuation)

**Modulart**

MM (Mastermodul / Master module)

**Vorkenntnisse / Previous knowledge**

- Basic knowledge in security
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<td>(depending on the number of students)</td>
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Inf461 - Security of Cyber-Physical Systems

Module label
Security of Cyber-Physical Systems

Module code
inf461

Credit points
3.0 KP

Workload
90 h

Used in course of study
- 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

Contact person
Module responsibility
- Sibylle Fröschle
- Die im Modul Lehrenden

Authorized examiners
- Die im Modul Lehrenden
- Sibylle Fröschle

Entry requirements
Skills to be acquired in this module
**Professional competences:** The students: - are aware of the threats posed by cyber attacks to cyber-physical systems - understand security solutions specific to CPS - know examples of security architectures of CPS - are able to apply this knowledge to assess the risk of cyber attacks to a given CPS as well as to develop a conceptual systems security architecture for it **Methodological competences:** The students: - carry out a threat and risk assessment for a given CPS - formulate security requirements for a given CPS - develop a systems security architecture for a given CPS to meet them (These are examples, the exact skills depend on the focus chosen by the student.) **Social competences:** The students: - are able to master a new topic by self-study and interaction with experts and peers - are able to explain the significance and facets of security for CPS to experts and non-experts - are able to expertly discuss security risks and incidents of CPS **Self-competences:** The students: - follow up and critically assess current developments in the security of CPS including relevant security incidents - are security aware and foster a security culture with respect to CPS and the resulting critical infrastructures

Module contents
Embedded systems in the energy, transportation, and health domains are currently undergoing a technological transition towards highly networked automated cyber-physical systems (CPS). Such systems are potentially vulnerable to cyber attacks, and these can have physical impact. This includes targeted sabotage of a plant (e.g. Stuxnet), large-scale sabotage of infrastructure to cause economic damage (e.g. attacks against energy grids), and indiscriminate attacks to cause civilian casualties (e.g. by compromise of transportation systems). In this module we investigate and discuss security principles, solutions, and architectures for CPS as well as real-life security incidents. The topics include distance bounding protocols, location tracking and counter-measures, safety and security engineering of CPS, security in the automotive and maritime domain including car hacking and vehicle-2-x communication, hacking in the medical domain, attacks against energy grids, Stuxnet, CPS and society: benefits, risks, acceptance.

Reader's advisory
Recent scientific papers and reports in the public domain news.

Links
http://vhome.offis.de/sibyllef

Language of instruction
English

Duration (semesters)
1 Semester

Module frequency
once a year

Module capacity
unlimited

Modullevel
AS (Akzentsetzung / Accentuation)

Modullevel
MM (Mastermodul / Master module)

Modulart
Pflicht o. Wahlpflicht / compulsory or optional

Modulart
je nach Studiengang Pflicht oder Wahlpflicht

Lern-/Lehrform / Type of program
S or V

Lern-/Lehrform / Type of program
S or V

Vorkenntnisse / Previous knowledge

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

Course type
Course or seminar

SWS
2.00

Frequency
SuSe or WiSe
| Workload attendance | 28 h |
inf522 - Information Processing in Bio-Medical Research

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**Used in course of study**
- Master's Programme Computing Science (Master) > Angewandte 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

**Contact person**
- Module responsibility
  - Rainer Röhrig
  - Die im Modul Lehrenden
- Authorized examiners
  - Die im Modul Lehrenden
  - Rainer Röhrig

**Entry requirements**
The students are aware of the requirements of biomedical research information processing and technologies. They know, develop and evaluate approaches.

**Skills to be acquired in this module**

**Professional competences:**
The students:
- Know the principles of biomedical research and identify resulting requirements and develop appropriate solutions
- Know the regulatory guidelines and assess the suitability of (IT) solutions or develop them
- Plan, apply, evaluate, report and assess IT solution evaluation studies
- Are aware of the biomedical research responsibility and the ethical challenges

**Methodological competences:**
The students:
- Search literature systematically
- Plan and assess clinical studies
- Develop concepts for a data privacy and GCP conform study management
- Know and apply medical classification systems
- Validate and run software for clinical trials, cohorts and registries
- Plan and assess healthcare IT studies

**Social competences:**
The students:
- Present solutions/results
- Discuss studies constructively, professionally and appropriately
- Discuss ethical biomedical research problems from different points of view

**Self-competences:**
The students:
- Reflect their own values and attitudes in the context of medical and biomedical research border areas
- Reflect their self-capacity with regard to the responsibility and the workload during the implementation of studies and the operation of study information systems

**Module contents**
- Basics / Biomedical research theory
- Systematic literature research, repositories
- Study schedule and method design
- Biomedical research regulatory framework
- Biomedical research ethics
- IT infrastructure in research / IT components incl. molecular medicine
- (Data) privacy
Operating of software for clinical trials, cohorts and registries
Clinical study report standards (Equator-Network), review process
Evaluation of healthcare IT (GEP-HI and STARE-HI) / evidence based healthcare informatics

<table>
<thead>
<tr>
<th>Reader's advisory</th>
<th>Wird im Modul bekannt gegeben</th>
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### inf523 - Medical Software Engineering

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**Used in course of study**
- Master's Programme Computing Science (Master) > Angewandte 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

**Contact person**
- **Module responsibility**
  - Rainer Röhrig
- **Authorized examiners**
  - Die im Modul Lehrenden
  - Rainer Röhrig

**Entry requirements**
- **Skills to be acquired in this module**
  - This Module provides the regulatory requirements of medical software. Focus is on software life cycle methods and approaches, the implementation of combined usability- and risk management processes as well as quality management.

  **Professional competence**
  - The students:
    - Know and use obligatory medical software requirements
    - Know methods and approaches to develop security-critical medical software and implement them by example
    - Know at least one medical application area and its specific professional, organisational and regulatory requirements

  **Methodological competence**
  - The students:
    - Are able to apply risk management methods of socio-technical systems
    - Are able to extend their knowledge of new application areas. They are able to handle the obstacles of normative frameworks and software development.

  **Social competence**
  - The students:
    - Realise the importance of communication during the software development process between developer, customer and user of a successful and secure system. Feedback, request, respectful cooperation and empathy of other disciplines' working processes are of great importance.

  **Self-competence**
  - The students:
    - Realise their responsibility as a computer scientist and reflect their impact on patients, medical employers and hospitals (corporates)

**Module contents**
- Content of the Module:
  - This module provides medical software development processes. The module deals with normative software requirements with the focus on patient privacy and quality management. Contents are the declaration of conformity based on medical product classes and software security classes. The software security is focused on software quality, tests and verification, validation as well as quality and risk management. The software life cycle provides security related systems and software as well as software architecture and different process models.

**Reader's advisory**
- wird im Modul bekannt gegeben

**Links**

**Languages of instruction**
- German, English
<table>
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<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
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<td>V + Ü</td>
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**Total time of attendance for the module**

56 h
### inf533 - Probabilistic Modelling I

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#### Used in course of study
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master’s Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

#### Contact person

- **Module responsibility**
  - Claus Möbus
  - Die im Modul Lehrenden

- **Authorized examiners**
  - Claus Möbus
  - Die im Modul Lehrenden

#### Entry requirements

- **Skills to be acquired in this module**
  - Probabilistic Bayesian models are generated with special tools (e.g. BUGS, JAGS, STAN) or domain specific programming languages (WebPPL, PyMC3, ...etc.). If they mimic cognitive processes of humans (e.g. pilots, drivers) or animals they could be used as cooperative assistance systems in technical or financial systems like cars, robots, or recommenders.

  - **Professional competence**
    - The students:
      - learn to map problem to model classes to come up with practical solutions

  - **Methodological competence**
    - The students:
      - acquire basic skills in the design, implementation, and identification of probabilistic models with Bayesian methods
      - acquire knowledge about alternative non-Bayesian machine learning methods

  - **Social competence**
    - The students:
      - learn to present and discuss probabilistic theories, methods, and models.

  - **Self-competence**
    - The students:
      - reflect and evaluate chances and limitations of probabilistic approaches
      - learn to deliberate on machine-learning alternatives

#### Module contents

- Theories, methods, and examples of Bayesian models with practical applications

#### Reader's advisory

- Recent eBooks, eTutorials

#### Links


#### Languages of instruction

- German, English

#### Duration (semesters)

- 1 Semester

#### Module frequency

- jährlich

#### Module capacity

- unlimited

#### Reference text

- Associated with the module:
  - inf534 Probabilistic Modelling II
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inf537 - Intelligent Systems

Module label: Intelligent Systems
Module code: inf537
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodul der Informatik
- Master's Programme Computing Science (Master) > Angewandte 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

Contact person:
Module responsibility:
- Jürgen Sauer
- Die im Modul Lehrenden

Authorized examiners:
- Jürgen Sauer
- Die im Modul Lehrenden

Entry requirements:
Skills to be acquired in this module:
**Professional competence** The students:
- name the structure of agent-based systems
- use problem-solving methods for complex problems
- characterise the application area of process planning
- evaluate the suitability of processes regarding to specific problems

**Methodological competence** The students:
- assign problem-solving methods to different problems

**Social competence** The students:
- implement selected methods in small teams

**Self-competence** The students:
- develop own solutions for given problems

Module contents:
A lot of application areas use "intelligent" problem-solving methods. These are the main focus of this lecture. They will be illustrated by examples in order to enhance the students' problem-solving abilities. These include:
- A brief introduction into AI
- Agent systems and
- Solution methods of AI like heuristics, meta-heuristics, soft computing methods.

To apply and foster the contents of the lecture, an intelligent planning system is implemented in practical exercises.

Reader's advisory:
Suggested reading:
- Ghallab/Nau/Traverso: Automated Planning, Morgan Kaufman, 2004

Links:
www.wi-ol.de

Languages of instruction:
German, English

Duration (semesters):
1 Semester

Module frequency:
Once a year

Module capacity:
Unlimited

Reference text:
Dieses Modul ist im Rahmen der Projekte FiF und FoL konzipiert worden

Modullevel:
AS (Akzentsetzung / Accentuation)

Modulart:
je nach Studiengang Pflicht oder Wahlpflicht

Lern-/Lehrform / Type of program:
V+Ü

Vorkenntnisse / Previous knowledge:
Produktionsorientierte Wirtschaftsinformatik

Examination:
Time of examination:
Final exam of module: At the end of the lecture period

Type of examination:
Practical exercises and oral exam or practical exercises and written exam or portfolio

Course type:
Lecture
Exercises

Comment:

SWS
2.00
2.00

Frequency
SuSe
SuSe

Workload attendance
28 h
28 h

Total time of attendance for the module:
56 h
inf650 - Transport Systems

Module label: Transport Systems
Module code: inf650
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodulle der Informatik
- Master's Programme Computing Science (Master) > Angewandte 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

Contact person:
Module responsibility:
- Axel Hahn
- Die im Modul Lehrenden

Authorized examiners:
- Axel Hahn
- Die im Modul Lehrenden

Entry requirements:

Skills to be acquired in this module:
Objective of the module/skills:
The Module Transport systems deals with planning and controlling systems of internal and external company logistics as well as public transport. It provides basic knowledge and recent research topics. The focus is on a resource orientated holistic view of company logistics as well as the planning of transport infrastructure. Furthermore, trends such as autonomous vehicles and intelligent transport systems are discussed.

Professional competence
The students:
- name the basics of planning and controlling company logistics
- assess transport systems of companies
- name methods and approaches of computer aided transport systems and classify them
- characterise software to plan complex logistics

Methodological competence
The students:
- display topics and concepts of transport systems
- simulate transport and its systems with appropriate methods

Social competence
The students:
- work in groups
- discuss their results appropriately

Self-competence
The students:
- realise their limits while working on a project containing aspects of modelling and implementation
- question the presentation of their results

Module contents:
- Transport and logistics concepts
- Data acquisition of company logistics
- Planning- and simulation software for complex logistics- and transport processes
- Energy- and resource efficient transport systems
- Resource oriented transport cost calculations (e.g. CO2, noise pollution)
- Planning models for transport infrastructure

Reader's advisory
Suggested reading:

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<th>Links</th>
<th><a href="http://wi-ol.de">http://wi-ol.de</a></th>
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<td>Exercises</td>
<td></td>
<td>2.00</td>
<td>SuSe</td>
<td>28 h</td>
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Total time of attendance for the module: 56 h
The Module practices the scientific competencies in preparation of the master thesis. It is intended to replace the project group with the two “Research Project” modules to ensure studibility and to enable students to perform research projects at foreign universities. Additionally, it is also intended to embed the student into the research activities of the supervisor in preparation of a potential doctoral work after finishing the program.

**Module contents**
Definition of a research question, identifying the state of the art, development of a research plan, performing research tasks, scientific writing, presentation of results.

**Professional competence**
The students:
- will extend their competences in the required technologies of the research area

**Methodological competence**
The students:
- will extend their competences in scientific methodologies, methods, and tools regarding the research area

**Social competence**
The students:
- will be integrated in the working group of the supervisor of the work and have to present as well as discuss the results within the working group

**Self-competence:**
The students:
- 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 hypothesis to theories independently
- Work in their field independently

**Reader’s advisory**
Will be announced by the supervisor according to the research topic.

**Links**
- **Languages of instruction**: English, German
- **Duration (semesters)**: 1 Semester
- **Module frequency**: Sommer und Winter
- **Module capacity**: unlimited
- **Modullevel**: BC (Basiscurriculum / Base curriculum)
- **Modulart**: je nach Studiengang Pflicht oder Wahlpflicht

**Vorkenntnisse / Previous knowledge**
- Lern-/Lehrform / Type of program: P
- Time of examination: Projekt
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inf300 - Hybrid Systems

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

Used in course of study:
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Computing Science (Master) > Theoretische Informatik
- Master's Programme Embedded Systems and Microelectronics (Master) > Akzentrumsmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Contact person:
Module responsibility:
- Martin Georg Fränzle
- Die im Modul Lehrenden

Authorized examiners:
- Martin Georg Fränzle
- Die im Modul Lehrenden

Entry requirements:

Skills to be acquired in this module:
The module gives an introduction to hybrid discrete-continuous systems, as arising by embedding digital hardware into physical environments, and it elaborates on state of the art methods for the mathematical modelling and the analysis of such systems. It thus provides central competences for understanding and designing reliable cyber-physical systems.

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

Methodological 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 interleavings between discrete computational and decision processes and continuous processes. The resulting processes are neither amenable to the analytic techniques of continuous control nor of discrete mathematics. They instead require a broader, integrated theory: hybrid discrete-continuous systems. The lectures provide an in-depth introduction into a variety of analysis and design methods of these computer-based...
systems and their recent extensions to cyber-physical systems

The accompanying hands-on-project enhances the lecture by developing and using design and verification tools.

Reader's advisory


Links

Languages of instruction  English, German
Duration (semesters)  1 Semester
Module frequency  once a year
Module capacity  unlimited
Module level  AS (Akzentsetzung / Accentuation)
Modular type  Pflicht o. Wahlpflicht / compulsory or optional
Lern- / Lehrform / Type of program  V+Ü
Vorkenntnisse / Previous knowledge  Bachelor in Computing Science oder Kenntnisse gewöhnlicher Differentialgleichungen
Examination  Time of examination  Type of examination
Final exam of module  At the end of the lecture period  Semester project including written work and final presentation

<table>
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Total time of attendance for the module  56 h
inf338 - Design of Autonomous Systems

Module label: Design of Autonomous Systems
Module code: inf338
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- 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

Contact person:
Module responsibility: Martin Georg Fränzle
Authorized examiners:
- Die im Modul Lehrenden
- Martin Georg Fränzle

Entry requirements:

Skills to be acquired in this module:
Professional competences: The students are enabled to analyze and build autonomous systems.
Methodological competences:
The students know examples of existing autonomous systems, understand the elements involved in their architectural design and the rationale behind decomposing the problem into obligations for the respective system components. The module furthermore enables the students to analyze existing architectures for autonomous systems with respect to their performance and safety. The students learn how to decompose a problem of designing an autonomous system into an architecture, are able to derive design obligations for its components, and can structure a pertinent safety case. They understand the software and hardware components necessary for achieving system autonomy and are able to design or instantiate these.
Social competences:
The students acquire hands-on experience in designing components for autonomous systems in small teams and present the underlying theory, their particular design decisions, and their personal evaluation to fellow students.
Self-competences:
The students can judge adequacy of their methodological skills for designing particular autonomous solutions. They are able to assess the safety impact of such a solution and are therefore able to develop a personal ethical stance towards its realization.

Module contents:
The module consists of a lecture and an exercise part

Reader's advisory:

Links:
Language of instruction: English
Duration (semesters): 1 Semester
Module frequency: once a year
Module capacity: unlimited
Modullevel: AS (Akzentsetzung / Accentuation)
Modulart: Pflicht o. Wahlpflicht / compulsory or optional
Lern-Lehrform / Type of program: V+Ü

Vorkenntnisse / Previous knowledge:

Examination:
Time of examination: Second half of semester
Type of examination: Presentation

Final exam of module:
Course type: Lecture
Comment: 2.00
SWS: SuSe or WiSe
Frequency: 28 h

Course type: Exercises
Comment: 2.00
SWS: SuSe or WiSe
Frequency: 28 h

Total time of attendance for the module: 56 h
inf657 - Product Engineering

Module label | Product Engineering
Module code | inf657
Credit points | 6.0 KP
Workload | 180 h

Used in course of study
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Contact person
Module responsibility
- Axel Hahn
- Die im Modul Lehrenden

Authorized examiners
- Axel Hahn
- Die im Modul Lehrenden

Entry requirements

Skills to be acquired in this module
Focus of this module is to learn and apply the product engineering process. A project will enable the students to design a product from the idea to the prototype. More specifically, a systematic, partial domain-specific, approach to solve technical problems and aspects of project management will be learned. Regular meetings are used to train the presentation capabilities of the students and to schedule working packages within the teams.

Professional competence
The students:
- learn and try out the handling of virtual and physical prototypes
- learn and try out the construction and validation of virtual prototypes with the aid of CAD-applications
- learn and combine different basic development concepts from the mechanical engineering, microelectronics, control engineering and software engineering

Methodological competence
The students:
- learn and try out project management concepts
- learn and recognise the connections of different development concepts from different fields, e.g. mechanical engineering, control engineering, microelectronics and software engineering
- develop own products with creativity techniques
- schedule and organise the product development supported by project management techniques independently
- learn the systematic refining of their own product idea with SysML
- design and test products with state-of-the-art CAD-applications

Social competence
The students:
- impart their structure and mode of action to other people
- develop their own products in small teams
- present their solutions to groups
- integrate criticism to their solutions
- support other groups by giving appropriate criticism

Self-competence
The students:
- recognise and reflect their own limitations to get familiar and to plan a project in an unknown field (e.g. maritime construction/industries)

Module contents
This module is a lecture accompanied by a hands-on project. The students work on one product development task.
The product development starts with the idea-finding/brainstorming process which is used to create a digital product concept. During the semester a digital prototype will be created and validated by its initial requirements. Finally, a physical prototype is produced with a 3D-Printer (Rapid Prototyping). The progress of the project has to be documented and presented at different milestones.

Reader's advisory
-Ehrlenspiel (2003): Integrierte Produktentwicklung
**-Ophey (2005): Entwicklungsmanagement, Methoden in der Produktentwicklung**

<table>
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**Vorkenntnisse / Previous knowledge**

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**Total time of attendance for the module**

56 h
**inf663 - Application Area Maritime**

**Module label**  
Application Area Maritime

**Module code**  
inf663

**Credit points**  
6.0 KP

**Workload**  
180 h

**Used in course of study**
- Master's Programme Computing Science (Master) > Angewandte 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

**Contact person**
Module responsibility  
- Axel Hahn

Authorized examiners  
- Axel Hahn
- Die im Modul Lehrenden

**Entry requirements**

**Skills to be acquired in this module**

**Professional competences:**
The students gain knowledge about ship handling and navigation and learn to understand maritime transportation as a system of systems with systems on board for stability, propulsion and steering as well as for bridge resource management. They understand the latter as a major contribution to organize navigation as a hierarchical team concept of a safety critical sociotechnical system. The students are aware of the complex technical and physical challenges of navigation.

**Methodological competences:**
The students can apply system engineering methods to describe, analyse and design maritime systems. By looking at maritime transportation the gain transferable knowledge on other cyber physical systems. Students learned to how systems can deal with harsh environmental conditions in a resilient way.

**Social competences:**
Maritime transportation is a major basis of a global economy. Typically, students do not have an understanding of these transportation systems nor their technical and systemic challenges. Therefore, the student knows the concepts of maritime transportation and its role in international transportation networks after finishing this module.

**Self-Competences:**
Especially their competences cover an understanding of maritime transportation as a systems of system with high requirements on reliability, dependability and safety in combination with efficiency to be competitive in a global economy.

**Module contents**
The module consists of a lecture and an exercise part:
- Lecture: Maritime Transportation in global and local supply chains, Base concepts of ship handling and navigation, maritime system dynamics, bridge resource management, eNAvigation and high automation systems.
- Seminar: Covering aspects of maritime transportation

**Reader's advisory**
Bernhard Berking, Werner Huth (Herausgeber), Handbuch Nautik 1: Navigatorische Schiffsführung, Seehafen Verlag, 2010

**Links**

**Language of instruction**  
English

**Duration (semesters)**  
1 Semester

**Module frequency**  
Once a year

**Module capacity**  
unlimited

**Modullevel**  
AS (Akzentsetzung / Accentuation)

**Modulart**  
Pflicht o. Wahlpflicht / compulsory or optional

**Lern-/Lehrform / Type of program**  
V+S

**Vorkenntnisse / Previous knowledge**

**Examination**

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**Course type**

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**Total time of attendance for the module**

56 h
Inf900 - Group Project

Module label: Group Project
Module code: inf900
Credit points: 24.0 KP
Workload: 720 h

Used in course of study:
- Master's Programme Business Informatics (Master) > Kernmodule
- Master's Programme Computing Science (Master) > Kernmodule
- Master's Programme Embedded Systems and Microrobotics (Master) > Kernmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Contact person:
Module responsibility:
- Die im Modul Lehrenden
Authorized examiners:
- Die im Modul Lehrenden

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

Additionally, students develop special knowledge, skills and competences from the project group topic.

Professional competence:
The students:
- characterise and apply computer science basics (algorithms, data structures, programming, basics of practical, technical and theoretical computer science)
- define and 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.

Reader's advisory:
According to the assigned task

Links:
https://www.uni-oldenburg.de/informatik/studium-lehre/infos-zum-studium/projektgruppen-im-masterstudium/

Languages of instruction:
German, English

Duration (semesters):
2 Semester
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<td>Dieses Modul ist im Rahmen der Projekte FiF und FoL konzipiert worden</td>
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<td>Modulart</td>
<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
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<tr>
<td>Lern-/Lehrform / Type of program</td>
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<tr>
<td>Vorkenntnisse / Previous knowledge</td>
<td>- Programmierkurs</td>
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<tr>
<td></td>
<td>- Softwaretechnik</td>
</tr>
<tr>
<td></td>
<td>- Soft Skills</td>
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<tr>
<td>Examination</td>
<td>Time of examination</td>
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<td>Im Stud.IP nach Bekanntgabe der einzelnen Gruppen und Themen</td>
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<td>Project group</td>
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<td>Frequency</td>
<td>SuSe and WiSe</td>
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<td>112 h</td>
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# inf502 - Simulation

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<th>Simulation</th>
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<tr>
<td>Module code</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>Master's Programme Business Informatics (Master) &gt; Akzentsetzungsmodulture der Informatik</td>
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<tr>
<td></td>
<td>Master's Programme Computing Science (Master) &gt; Angewandte Informatik</td>
</tr>
<tr>
<td></td>
<td>Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Systems Engineering</td>
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<tr>
<td>Contact person</td>
<td>Module responsibility</td>
</tr>
<tr>
<td></td>
<td>▪ Axel Hahn</td>
</tr>
<tr>
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<td>▪ Jürgen Sauer</td>
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<tr>
<td>Authorized examiners</td>
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<td>▪ Jürgen Sauer</td>
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<tr>
<td>Entry requirements</td>
<td>Skills to be acquired in this module</td>
</tr>
<tr>
<td></td>
<td>Simulation is a major tool for gaining knowledge about systems and their behavior. It can be used to gain system understanding and prediction future system status. The module covers mathematical basic as well a basic simulation technology. The module completes itself by addressing application examples. By seminar and practical work, the students get hands on experience of simulation technologies.</td>
</tr>
<tr>
<td></td>
<td>Professional competence</td>
</tr>
<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>▪ get an overview on methods, tools and application areas of simulation. They know what simulation can do and what are its limitation. Covered application are mainly in transportation and production domain.</td>
</tr>
<tr>
<td></td>
<td>Methodological competence</td>
</tr>
<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>▪ know simulation technologies and model building basics. They understand the handling of time and problems of discretization. After lecture students can solve problems with simulation. This includes modelling, use of simulation environment and evaluation of results. Cause of practical use, the independent handling of research questions and the use of simulation as research method will be learned.</td>
</tr>
<tr>
<td></td>
<td>Social competence</td>
</tr>
<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>▪ gain team and social skills by self-organized development of simulation.</td>
</tr>
<tr>
<td></td>
<td>Self-competence</td>
</tr>
<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>▪ can apply simulation technologies on scientific research questions.</td>
</tr>
<tr>
<td>Module contents</td>
<td>In lectures the students get background information and simulation basics. Then they apply their knowledge by developing an own simulation by using state of the art simulation environments</td>
</tr>
<tr>
<td>Links</td>
<td>Languages of instruction</td>
</tr>
<tr>
<td></td>
<td>Duration (semesters)</td>
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<td></td>
<td>Module frequency</td>
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<tr>
<td>Module capacity</td>
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<td>Modulart</td>
<td>je nach Studiengang Pflicht oder Wahlpflicht</td>
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<tr>
<td>Lern-/Lehrform / Type of program</td>
<td>V+S+P</td>
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<tr>
<td>Vorkenntnisse / Previous knowledge</td>
<td>Programmierkenntnisse vornehmlich in Java sind zwingend erforderlich</td>
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<td>Examination</td>
<td>Time of examination</td>
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<td>Anmeldung 2 Wochen nach Vorlesungsbeginn</td>
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<td>Practical</td>
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**inf551 - Maritime Systems**

**Module label**  
Maritime Systems

**Module code**  
in551

**Credit points**  
6.0 KP

**Workload**  
180 h

**Used in course of study**
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte 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

**Contact person**

**Module responsibility**
- Axel Hahn

**Authorized examiners**
- Axel Hahn
- Die im Modul Lehrenden

**Entry requirements**

**Skills to be acquired in this module**
The module deals with the economic aspects and synergy effects of maritime sub-areas. In addition to the basic knowledge of the maritime sub-areas, current approaches from research are taught. The basic ship parameters are examined with regard to their economic efficiency, stability calculations and ship dynamics are derived and effects of the ship hull, propellers and systems on the economic efficiency of a ship are considered. The focus here is on understanding economic thinking and the interaction of the sub-areas. Furthermore, future-oriented solutions and trends will be discussed. **Professional competence** The students - name the basics of planning and control of operational logistics in a shipyard - name the basics of planning of economic design - recognise the application possibilities of simulation in design, construction and dynamics - identify the basic maritime sub-areas and their synergies **Methodological competence** The students - Link relations with tree structures - Illustrate the questions and concepts of the design process **Social competence** The students - Present computational problem solving to groups - Discuss their outcomes appropriately - Implement solutions of given problems in teams - Accept criticism of their peer group as valuable contributions **Self-competence** The students - reflect their self-image and their actions of their results

**Module contents**

**Reader's advisory**

**Links**
http://www.wi-ol.de

**Languages of instruction**
German, English

**Duration (semesters)**
1 Semester

**Module frequency**
annually in winterterm

**Module capacity**
unlimited

**Modullevel**
AS (Akzentsetzung / Accentuation)

**Modullevel**
AS (Akzentsetzung / Accentuation)

**Modulart**
Wahlmodul / Opportunity

**Modulart**
Wahlmodul / Opportunity

**Lern-/Lehrform / Type of program**
V+Ü

**Lern-/Lehrform / Type of program**
V + Ü

**Vorkenntnisse / Previous knowledge**
Transportsysteme, Analysis, Differentialgleichungen, lineare Algebra, Mechanik

**Vorkenntnisse / Previous knowledge**
Transportsysteme, Analysis, Differentialgleichungen, lineare Algebra, Mechanik

**Examination**

**Time of examination**
at the end of the lecture period

**Type of examination**
practical exercises and oral examination

<table>
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<td>Exercises</td>
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<td>56 h</td>
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Abschlussmodul

mam - Master`s Thesis Module

Module label | Master`s Thesis Module
Module code | mam
Credit points | 30.0 KP
Workload | 900 h

Used in course of study
- Master's Programme Engineering of Socio-Technical Systems (Master) > Abschlussmodul

Contact person
Module responsibility
- Lehrende der Informatik

Authorized examiners
- Lehrende der Informatik

Entry requirements

Skills to be acquired in this module
The students prove that they are able to process and solve complex computer science tasks based on gained scientific knowledge and applied research methods. The students successfully implement a task especially by using their acquired professional and methodological knowledge and their professional and social competences.

The accompanying seminar is used to discuss the master's thesis methodically and content-related. During the seminar the exchange of research and practical experience fosters the students' ability to discuss and evaluate their thesis with other students and experts.

The master's thesis is finished by a colloquium.

Professional competences:
The students:
- Recognise and evaluate applied techniques and methods of their subject and are aware of their limits
- Design solutions for complex, possibly vaguely defined or unusual computer science tasks/problems and evaluate these with reference to state of the art computer science and technology
- Identify, structure and solve problems/tasks, also in new or developing subject areas
- Apply state of the art and innovative methods to solve problems, if necessary from other disciplines
- Relate knowledge from different disciplines and apply this new knowledge in complex situations
- Develop complex computer systems, processes and datamodels
- Are aware of the current limits and contribute to the development of computer science research and technology
- Discuss and evaluate recent computer science developments

Methodological competences:
The students:
- Identify and develop one or more solutions
- Evaluate and apply tools, technology and methods sophisticatedly
- Examine tasks with technical and research literature, write an academic article and present their solutions academically
- Schedule processes and resources
- Apply project management techniques
- Combine new and original approaches and methods creatively
- Evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research

Social competences:
The students:
- Communicate with users and experts convincingly
- Take reasonable decisions

Self-competences:
The students:
- Pursue the overall and special computer science development critically
- Implement innovative professional activities effectively and independently
- Recognise their abilities and extend them purposefully
- Reflect their self-perception and actions with regard to professional, methodological and social aspects
- Develop and reflect self-developed hypothesis to theories independently
- Work in their field independently

<table>
<thead>
<tr>
<th>Module contents</th>
<th>The content of this module is an independent topic research. The research findings will be presented and discussed in a master's thesis colloquium.</th>
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<tbody>
<tr>
<td>Reader's advisory</td>
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<tr>
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