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

Module name: Fundamental Competences in Computing Science I: Signals and Dynamical Systems
Module code: inf960
ECTS credit points: 6.0 KP
Workload: 180 h

Used in degree programmes:
- Master Engineering of Socio-Technical Systems > Basiskompetenzen/Grundlagen

Contact person:
- module responsibility
  - Martin Georg Fränzle
  - Andreas Hein
- authorized examiners
  - Die im Modul Lehrenden

Prerequisites

Skills to be acquired in this module

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

Content of the module:

- 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

Module contents

Recommended reading
### Links

<table>
<thead>
<tr>
<th>Language of instruction</th>
<th>English</th>
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<tbody>
<tr>
<td>Duration (semesters)</td>
<td>1 semester</td>
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<tr>
<td>Module frequency</td>
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<tr>
<td>Module capacity</td>
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<tr>
<td>Module level</td>
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<tr>
<td>Modulart</td>
<td>je nach Studiengang Pflicht oder Wahlplicht</td>
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### Lern-/Lehrform / Type of program

### Vorkenntnisse / Previous knowledge

### Examination / examination periods / Type of examination

<table>
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<th>Final exam of module</th>
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<tr>
<td>Course type</td>
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<tr>
<td>Lecture</td>
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<tr>
<td>Exercises</td>
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</table>

**Total attendance time of module**

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

<table>
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<th>Module name</th>
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<tr>
<td>ECTS credit points</td>
<td>6.0 KP</td>
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<td>Workload</td>
<td>180 h</td>
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**Contact person**
- module responsibility
  - Heinz-Georg Quebbemann
  - Florian Heß
  - Sandra Stein
  - Andreas Stein
  - Martin Georg Fränzle
- authorized examiners
  - Die im Modul Lehrenden

**Prerequisites**

**Skills to be acquired in this module**
The courses provides 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.

**Professional competences:**
The students:
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:
The students are able to explain mathematical formalisations 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.

**Recommended reading**
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**
once a year

**Module capacity**
unlimited

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

**Modulart**
je nach Studiengang Pflicht oder Wahlpflicht

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

**Vorkenntnisse / Previous knowledge**

**Examination**

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**Course type**

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<th>Workload attendance</th>
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| Workload attendance | 28 h |

**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.

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**Links**

**Language of instruction**
English

**Duration (semesters)**
1 semester

**Module frequency**
once a year

**Module capacity**
unlimited

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

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

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**Links**

**Language of instruction**
English

**Duration (semesters)**
1 semester

**Module frequency**
once a year

**Module capacity**
unlimited

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

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V+Ü

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Inf962 - Fundamental Competences in Computing Science III: Algorithms and Computational Problem Solving

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<td>Lehrende der Informatik</td>
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<td>authorized examiners</td>
<td>Die im Modul Lehrenden</td>
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**Prerequisites**

**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.

**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

**Recommended reading**

**Language of instruction**

English

**Duration (semesters)**

1 semester

**Module frequency**

**Module capacity**

unlimited

**Modullevel**

BC (Basiscurriculum / Base curriculum)

**Modulart**

je nach Studiengang Pflicht oder Wahlpflicht

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

V+Ü

**Vorkenntnisse / Previous knowledge**

Knowledge of a programming language may be helpful, but is not required

**Examination**

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<td>Exercises</td>
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**Total attendance time of module**

56 h
inf963 - Foundations of STS Eng.: Cognitive Processes

<table>
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<td>Module code</td>
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<td>ECTS credit points</td>
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<td>Workload</td>
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<td>• Master Engineering of Socio-Technical Systems &gt; Basiskompetenzen/Grundlagen</td>
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<td>module responsibility</td>
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<td></td>
<td>• Martin Georg Fränzle</td>
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<td></td>
<td>authorized examiners</td>
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<td></td>
<td>• Die im Modul Lehrenden</td>
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</table>
| Prerequisites               | 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 behaviour 
  • 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:  
The students: 
• Neuropsychological / neurophysiological knowledge 
Methodological competences:  
The students: 
• interdisciplinary knowledge & thinking 

Social competences:  
The students: 
• Written and oral presentation and discussion of scientific and technical results with others. 

Self-competences:  
The students: 
• Reading, understanding, summarizing and critically evaluating scientific texts/literature 

Module contents

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<tbody>
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<td>Links</td>
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<td>Language of instruction</td>
<td>English</td>
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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>Information</td>
<td>The module will be offered in winter terms and should be completed within one semester. Both parts will run in parallel.</td>
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<td>Modulelevel</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+S</td>
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<tr>
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<td>2 WinSem 28 h</td>
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<tr>
<td>Seminar</td>
<td>2 WinSem 28 h</td>
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<td>Total attendance time of module</td>
<td>56 h</td>
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inf964 - Foundations of STS Eng.: Psychology and Philosophy of Technology

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<th>Foundations of STS Eng.: Psychology and Philosophy of Technology</th>
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<td>ECTS credit points</td>
<td>6.0 KP</td>
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<td>Workload</td>
<td>180 h</td>
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<td>Used in degree programmes</td>
<td>• Master Engineering of Socio-Technical Systems &gt; Basiskompetenzen/Grundlagen</td>
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<td></td>
<td>• Rainer Röhrig</td>
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<td></td>
<td>authorized examiners</td>
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<td></td>
<td>• Die im Modul Lehrenden</td>
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<tr>
<td>Prerequisites</td>
<td></td>
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<tr>
<td>Skills to be acquired in this module</td>
<td>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 in to 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 Competencies: and</td>
</tr>
<tr>
<td>Professional competences:</td>
<td>The students</td>
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<tr>
<td></td>
<td>• Should have a repertoire of cognitive psychology concepts relevant for real world situations</td>
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<td></td>
<td>• should be able to familiarize themselves with important ethical concepts, are able to explain them, and transmit them on scenarios of the technology assessment</td>
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<td></td>
<td>• should know and be able to explain different forms and concepts of technology assessments (Expert, participatory, constructive, discursive Technology Assessment, Health Technology Assessment (HTA)</td>
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<td>• should be able to reflect the collingridge dilemma</td>
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<tr>
<td>Methodological competences:</td>
<td>The students</td>
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<tr>
<td></td>
<td>• should be able to transfer the learned theoretical concepts into practical contexts</td>
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<td></td>
<td>• should be able to perform an systematic literature review</td>
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<tr>
<td></td>
<td>• should be able to evaluate potential issues arising in the process of translation</td>
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<tr>
<td></td>
<td>• should be able to do an risk-benefit analysis and cost-benefit analysis of given examples</td>
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<td></td>
<td>• should know and can explain empirical methods for technology assessment</td>
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<td>• Methodological considerations: Generalization, validity of theories and research methods</td>
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<tr>
<td>Social competences:</td>
<td>The students</td>
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<tr>
<td></td>
<td>• should be able to argue on different point of views based on different</td>
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<td>Self-competences:</td>
<td>The students</td>
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<tr>
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<td>• should be able to reflect their own attitudes and able to explain them using ethical principles</td>
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<td>• Pursuing goals: Thinking, problem solving and acting</td>
</tr>
<tr>
<td>Module contents</td>
<td>The module consists of a lecture and an seminar part:</td>
</tr>
<tr>
<td></td>
<td>Lecture:</td>
</tr>
<tr>
<td></td>
<td>• Neurocognitive Psychology with emphasis in real world context</td>
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<td>• Ethical Principals an Concepts</td>
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<td></td>
<td>• Forms and Concepts of Technology Assessment</td>
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<td></td>
<td>• Chances and Limitations of Technology Assessment</td>
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<td></td>
<td>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.</td>
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<td>Seminar:</td>
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<td>The students write a term paper 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.</td>
</tr>
<tr>
<td>Recommended reading</td>
<td>Part 1: Psychology of Technology</td>
</tr>
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<td>Links</td>
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<td>1 semester</td>
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<td>Module capacity</td>
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<td>Seminar</td>
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<td>2</td>
<td>SumSem and WinSem</td>
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| Total attendance time of module | 56 h |
### inf965 - Foundations of STS Eng.: Systems Engineering

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<td>✪ Axel Hahn</td>
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<td>✪ Martin Georg Fränzle</td>
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<td>authorized examiners</td>
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<td>✪ Die im Modul Lehrenden</td>
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</table>

#### Prerequisites

Skills to be acquired in this module

**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 cornerstone is to know the concept of a system and to describe it using appropriate modelling techniques. The student starts think in systems as an aggregation of components systems 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 hole including humans a 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-competences:s 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 an modelling approach.

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

#### Recommended reading


#### Links

Language of instruction: English

Duration (semesters): 1 semester

Module frequency: unlimited

Module level: BC (Basiccurriculum / Base curriculum)

Modulart: Pflicht o. Wahlpflicht / compulsory or optional

Lern-/Lehrform / Type of program: V+Ü

Vorkenntnisse / Previous knowledge

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**Total attendance time of module:** 56 h
### inf966 - Foundations of STS Eng.: Statistics and Programming

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<tr>
<td></td>
<td>Antje Timmer</td>
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<td></td>
<td>Andreas Hein</td>
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<td></td>
<td>Die im Modul Lehrenden</td>
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</table>

#### Prerequisites

**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 are put on statistically methodology 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 paperbased use of the learned concepts, methods and tools.

#### Recommended reading

#### Links

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<th><strong>Language of instruction</strong></th>
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inf970 - Fundamental Competences in Psychology I: Psychology

**Module name**
Fundamental Competences in Psychology I: Psychology

**Module code**
inf970

**ECTS credit points**
6.0 KP

**Workload**
180 h

**Used in degree programmes**
- Master Engineering of Socio-Technical Systems > Basiskompetenzen/Grundlagen

**Contact person**
module responsibility
- Christoph Siegfried Herrmann
authorized examiners
- Die im Modul Lehrenden

**Prerequisites**

**Skills to be acquired in this module**

**Professional competence**
The students:
- will acquire basic knowledge in selected topics of Psychology

**Methodological competence**
The students:
- learn selected methods and theories of Psychology

**Social competence**
The students:
- will learn to work together in small groups
- will communicate scientific theories

**Self-competences**
The students:
- will learn to apply their knowledge in other, more specific Psychology courses

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

**Lecture:**
The lecture will be based mainly on the textbook by Atkinson & Hilgards. It will introduce the students to selected topics of Experimental Psychology which are relevant for socio-technical systems (e.g., learning & memory, perception, language, emotion). It will also cover aspects of Social Psychology, Psychological Disorders, and Individual Psychology.

**Exercises:**
To be written by Prof. Hein

**Recommended reading**

**Links**

**Language of instruction**
English

**Duration (semesters)**
1 semester

**Module frequency**
once a year

**Module capacity**
unlimited

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

**Modulart**
je nach Studiengang Pflicht oder Wahlpflicht

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

**Vorkenntnisse / Previous knowledge**

**Examination**

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**Course type**
Comment
SWS
Offer rhythm
Workload attendance

12 / 138
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inf971 - Fundamental Competences in Psychology II: Introduction to Cognitive Neuroscience

Module name: Fundamental Competences in Psychology II: Introduction to Cognitive Neuroscience

Module code: inf971

ECTS credit points: 6.0 KP

Workload: 180 h

Used in degree programmes:
- Master Engineering of Socio-Technical Systems > Basiskompetenzen/Grundlagen

Contact person
- module responsibility
  - Christiane Margarete Thiel
- authorized examiners
  - Die im Modul Lehrenden

Prerequisites

Skills to be acquired in this module

Introduction to basic concepts of neurological 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.

Recommended reading

Links

Language of instruction: English

Duration (semesters): 1 semester

Module frequency: once a year

Module capacity: unlimited

Information: This is part of a neurobiology module offered for biology students

Modulart: Pflicht o. Wahlpflicht / compulsory or optional

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

Vorkenntnisse / Previous knowledge

Examination

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| Total attendance time of module | 56 h |

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inf972 - Fundamental Competences in Psychology III: Experiments and Studies

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<td>Susanne Boll-Westermann</td>
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<td>Die im Modul Lehrenden</td>
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<td>Prerequisites</td>
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<td>The students:</td>
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<td>• see Content of the module</td>
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<td>Methodological competences:</td>
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<tr>
<td></td>
<td>The students are introduced into the design, implementation and also the analysis and interpretation of experiments.</td>
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<td>Social competences:</td>
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<td>Self-competences:</td>
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<tr>
<td></td>
<td>The students have knowledge of the tools and methods used for experiment design and evaluation. They are able to chose the right methods for their specific experiment. They are able to design and run experiments.</td>
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<tr>
<td>Module contents</td>
<td>Introduction into experimental psychology</td>
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<tr>
<td></td>
<td>• Variables, dependent and independent variables</td>
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<td>• Formulating Hypotheses / Hypothesis testing</td>
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<td>• Correlation and Cause</td>
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<td>• Quantitative and qualitative methods</td>
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<td>• Surveys, Experiments, Observational Studies</td>
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<td>Experiment design / Study designs</td>
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<td>• Between-Subjects Experiments</td>
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<td>• Within-Subjects Experiments</td>
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<td>• Randomized Control Trials</td>
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<td>• Practical Considerations</td>
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<td>• Complex Research Designs</td>
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<td>• Single-Subject Research</td>
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<td>• Lab studies vw. Studies in the wild</td>
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<td>• Single factor vs. multifactor designs</td>
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<td>Participants</td>
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<td>• Recruiting participants</td>
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<td>• Participants sampling</td>
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<td>• SoSci Survey for online survery</td>
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<td>• Descriptive statistics and Correlation coefficients</td>
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<td>• Statistical analysis of the data</td>
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<td>• Internal and external validity</td>
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<td>• Informed Consent</td>
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<td>The module consists of a lecture and an exercise part:</td>
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<tr>
<td></td>
<td>Lecture: Theoretical introduction into the concepts and scientific methods of experiment design.</td>
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<tr>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>Recommended reading</td>
<td>Das psychologische Experiment, Eine Einführung, Osswald Huber, 2005</td>
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<td></td>
<td>How to Design and Report Experiments, Andy Field, sage 2003</td>
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**Lern-/Lehrform / Type of program**

**Vorkenntnisse / Previous knowledge**

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<th>Type of examination</th>
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**Total attendance time of module** 56 h
Human-Computer Interaction
inf100 - Human Computer Interaction

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**Used in degree programmes**
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodule
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Informatik > Mastermodule
- Master Wirtschaftsinformatik > Bereichswahlmodule

**Contact person**
- module responsibility
  - Susanne Boll-Westermann
  - Die im Modul Lehrenden
- authorized examiners
  - Susanne Boll-Westermann
  - Die im Modul Lehrenden

**Prerequisites**

**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.

**Recommended reading**
- 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

**Language of instruction**
German

**Duration (semesters)**
1 semester

**Module frequency**
one a year

**Module capacity**
unlimited

**Modullevel**
AS (Akzentsetzung / Accentuation)
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<th>Type of examination</th>
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<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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<table>
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inf131 - Advanced Topics in Human Computer Interaction

Module name: Advanced Topics in Human Computer Interaction

Module code: inf131

ECTS credit points: 6.0 KP

Workload: 180 h

Used in degree programmes:
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Informatik > Mastermodule

Contact person:
- module responsibility: Susanne Boll-Westermann
- authorized examiners: Die im Modul Lehrenden

Prerequisites:
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.

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 artifacts

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 lectures 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.

**Recommended reading**

- Design of Everyday Things, Chapters 1 to 7

**Links**

**Language of instruction**

- English

**Duration (semesters)**

- 1 semester

**Module frequency**

**Module capacity**

- 24

**Module level**

- AS (Akzentsetzung / Accentuation)

**Module art**

- Pflicht o. Wahlpflicht / compulsory or optional

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

- V+P

**Vorkenntnisse / Previous knowledge**

- Interaktive Systeme

**Examination**

**examination periods**

- Final exam of module: At the end of the lecture period

**Type of examination**

- Project and oral exams

**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:

**Scored Items %**

- Final 40
- Assignments A01–03 30
- Mini HCI research project 20

**Course type**

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<th>SWS</th>
<th>Offer rhythm</th>
<th>Workload attendance</th>
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<tr>
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**Total attendance time of module**

- 56 h
inf174 - Special Topics in 'Media Informatics and Multimedia Systems' II

Module name | Special Topics in 'Media Informatics and Multimedia Systems' II
Module code | inf174
ECTS credit points | 6.0 KP
Workload | 180 h

Used in degree programmes
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Informatik > Mastermodule

Contact person
- module responsibility
  - Susanne Boll-Westermann
- Module counseling
  - Die im Modul Lehrenden

Prerequisites

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

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

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

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

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

Module contents | According to the assigned course
Recommended reading | As announced in course

Languages of instruction | German, English
Duration (semesters) | 1 semester
Module frequency | unregelmäßig
Module capacity | unlimited
Modullevel | AS (Akzentsetzung / Accentuation)
Modulart | Pflicht o. Wahlpflicht / compulsory or optional
Lern-/Lehrform / Type of program | 2 courses out of V, S, Ü, P, PR

Vorkenntnisse / Previous knowledge

Examination | examination periods | Type of examination
| Final exam of module | At the end of the lecture period | Portfolio or presentation or oral exam |
inf175 - Special Topics in 'Media Informatics and Multimedia Systems' II

<table>
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<tr>
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<th>Special Topics in 'Media Informatics and Multimedia Systems' II</th>
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<tr>
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<tr>
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<td>6.0 KP</td>
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<tr>
<td>Workload</td>
<td>180 h</td>
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</table>
| Used in degree programmes          | Master Engineering of Socio-Technical Systems > Human-Computer Interaction  
                                        Master Informatik > Mastermodule |
| Contact person                     |                                                               |
| module responsibility              |                                                               |
|   » Susanne Boll-Westermann        |                                                               |
| Module counseling                  |                                                               |
|   » Die im Modul Lehrenden         |                                                               |
| Prerequisites                      |                                                               |
| Skills to be acquired in this module | This module integrates current developments in the field in adequate study courses. |
| Professional competences           |                                                               |
| The students:                     |                                                               |
|   » Define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general | |
|   » Recognise and evaluate applied techniques and methods of their subject and are aware of their limits | |
|   » Identify, structure and solve problems/tasks, also in new or developing subject areas | |
|   » Apply state of the art and innovative methods to solve problems, if necessary from other disciplines | |
|   » Are aware of the current limits and contribute to the development of computer science research and technology | |
|   » Discuss and evaluate recent computer science developments | |
| Methodological competences         |                                                               |
| The students:                     |                                                               |
|   » Evaluate and apply tools, technology and methods sophisticatedly | |
|   » Combine new and original approaches and methods creatively | |
|   » Evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research | |
| Social competences                |                                                               |
| The students:                     |                                                               |
|   » Support team process by their abilities | |
| Self-competences                  |                                                               |
| The students:                     |                                                               |
|   » Pursue the overall and special computer science development critically | |
|   » Implement innovative professional activities effectively and independently | |

<table>
<thead>
<tr>
<th>Module contents</th>
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<tr>
<td>Recommended reading</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>2 courses out of V, S, Ü, P, PR</td>
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<td>Type of examination</td>
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<tr>
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<td>At the end of the lecture period</td>
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</table>
inf301 - Machine-oriented Systems Engineering

Module name: Machine-oriented Systems Engineering
Module code: inf301
ECTS credit points: 6.0 KP
Workload: 180 h

Used in degree programmes:
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodule
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

Contact person:

module responsibility
- Alfred Mikschl
- Werner Damm

authorized examiners
- Die im Modul Lehrenden

Prerequisites:
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.

Recommended reading:
Lecturers notes, hardware manuals and data sheets, and development tool manuals

Links:
Languages of instruction: German, English
Duration (semesters): 1 semester
Module frequency: semi-annual
Module capacity: unlimited
Modulart: Pflicht o. Wahlpflicht / compulsory or optional
Lern-/Lehrform / Type of program: V+P
Vorkenntnisse / Previous knowledge: „Eingebettete Systeme I and II”and successful completion of the module „Praktikum Technische Informatik”

Examination:

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

<table>
<thead>
<tr>
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<th>Comment</th>
<th>SWS</th>
<th>Offer rhythm</th>
<th>Workload attendance</th>
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<td></td>
<td><strong>56 h</strong></td>
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</table>
inf303 - Fuzzy Control and Artificial Neural Networks in Robotics and Automation

Module name: Fuzzy Control and Artificial Neural Networks in Robotics and Automation
Module code: inf303
ECTS credit points: 6.0 KP
Workload: 180 h

Used in degree programmes:
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodule
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

Contact person:
- module responsibility: Sergej Fatikow
- Die im Modul Lehrenden
- authorized examiners: Sergej Fatikow
- Die im Modul Lehrenden

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

Recommended reading

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, Systhema Verlag, München, 1992
- Patterson, D.W.: Künstliche neuronale Netze, Prentice Hall, 1996
- Pham, D.T. a200
- Schulte, U.: Einführung in Fuzzy-Logik, Franzius-Verlag, München, 1993
- Zakharian, S. Ladewig-Riebler, P. und Thoer, St.: Neuronale Netze für Ingenieure, Vieweg, Wiesbaden, 1998
- Zimmermann H.-J. (Hrsg.): Datenanalyse, VDI-Verlag, 1995

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: Control engineering

Examination
- examination periods: At the end of the lecture period until the beginning of the next semester
- Type of examination: Hands-on-exercises and oral Exam

Course type
- Comment: SWS
- Offer rhythm
- Workload attendance
- Lecture: 3 / 42 h
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<th>Comment</th>
<th>SWS</th>
<th>Offer rhythm</th>
<th>Workload attendance</th>
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<td></td>
<td></td>
<td></td>
<td>56 h</td>
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</table>
inf305 - Medical Technology

Module name: Medical Technology
Module code: inf305
ECTS credit points: 6.0 KP
Workload: 180 h

Used in degree programmes:
- Master Eingebettete Systeme und Mikrobotik > Akzentsetzungsmodul
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

Contact person:
- module responsibility: Andreas Hein
- authorized examiners:
  - Die im Modul Lehrenden
  - Andreas Hein

Prerequisites:

Skills to be acquired in this module:

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

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

Social competence:
The students:
- Present solutions for specific questions

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

Module contents:

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

Recommended reading:

essential:
- Lecture slides

recommended:

**secondary literature:**


### Links

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<td>Modul level</td>
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### Examination

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<td>Course type</td>
<td>Portfolio: Hands-on exercises, report, and written or oral exam</td>
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| Total attendance time of module | 56 h |

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<th>Workload attendance</th>
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</tbody>
</table>
inf307 - Robotics

Module name: Robotics
Module code: inf307
ECTS credit points: 6.0 KP
Workload: 180 h

Used in degree programmes:
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungs module
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

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

Prerequisites:

Skills to be acquired in this module:

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

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

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

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

Module contents:

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

Recommended reading

**essential:**
lecture notes

**recommended:**

**secondary literature:**

| Links | English | German
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| Comment | 33 / 138 |
inf308 - Microrobotics II

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<td>Master Engineering of Socio-Technical Systems &gt; Embedded Brain Computer Interaction</td>
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<td>Die im Modul Lehrenden</td>
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<tr>
<td>Prerequisites</td>
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Skills to be acquired in this module

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

Professional competence
The students:

- Name and recognise the basic concepts of nanotechnology, in particular, micro- and nanorobotics approaches
- Differentiate the development, control and application of micro- and nanorobotics systems
- Implement and design application-specific micro- and nanorobotics systems

Methodological competence
The students:

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

Social competence
The students:

- Work in a team

Self-competence
The students:

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

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

Recommended reading

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

Links
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inf330 - Embedded Systems

Module name: Embedded Systems
Module code: inf330
ECTS credit points: 6.0 KP
Workload: 180 h

Used in degree programmes:
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction

Contact person:
- Module responsibility:
  - Werner Damm
  - Wolfgang Nebel
  - Martin Georg Fränzle
- Authorized examiners:
  - Die im Modul Lehrenden

Prerequisites:

Skills to be acquired in this module:

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.

Recommended reading:

- 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 Kinotechnik" (BIS: Z elt ZA 1536)

Links

Language of instruction  English
Duration (semesters)  1 semester
Module capacity  unlimited

Information

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

Modulelevel  AS (Akzentsetzung / Accentuation)
Moduleart  Pflicht o. Wahlpflicht / compulsory or optional
Lern-/Lehrform / Type of program  V+U
Vorkenntnisse / Previous knowledge
  - Grundlagen der technischen Informatik
  - Technische Informatik

Associated with the module(s):
In the module "Eingebettete Systeme II" additional relevant topics such as design processes, HW/SW-Partitioning, High-Level-Synthesis and Hardware discription languages are discussed. The modules Eingebettete Systeme I und II offer cross-references to the module "Rechnerarchitektur", "Reallzeitbetriebssysteme" and semantic orientated modules of theoretical computer science. It is possible to enhance the knowledge of embedded systems design by attending the modules "System Level Design" and "Low energy System Design".

Examination

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Course type  Comment  SWS  Offer rhythm  Workload attendance

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Total attendance time of module  56 h
inf333 - Sensor Technology in the Automotive Domain

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<td>module responsibility</td>
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<td>间接 Frank Köster</td>
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<td>Skills to be acquired in this module</td>
<td>This module introduces the principles of sensors and sensor-systems as well as data-fusion in the automotive domain.</td>
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<td>Professional competences:</td>
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<tr>
<td></td>
<td>• Discuss different levels/diverse levels sensor-technologies</td>
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<td></td>
<td>• Discuss sensor-data fusion (multi-level fusion)</td>
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<td>• Discuss Kalman-Filter</td>
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<td>• Discuss in-vehicle data-processing</td>
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<td>• Discuss car2x-technologies</td>
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<td></td>
<td>• Design simple multi-sensor systems</td>
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<td>• Evaluate multi-sensor systems</td>
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<td>Methodological competences:</td>
<td>The students: Type of driver - entry/exit, type of parking, vehicle identification, vehicle status, vehicle features.</td>
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<tr>
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<td>• Analyze multi-sensor systems</td>
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<td>• Design multi-sensor systems</td>
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<td>• Evaluate multi-sensor systems</td>
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<td>• Discuss their outcomes appropriately</td>
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<td>• Acknowledge the limits of their ability to cope with pressure during the work on the topics of the module</td>
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Module contents

- Sensor-technologies
- Data fusion (multi-level fusion)
- Kalman-Filter
- In-vehicle data-processing
- Car2x-technologies (ITS G5 and 5G)
- Multi-sensor and multi-level fusion architectures

Recommended reading

Suggested reading:

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<th><strong>Type of examination</strong></th>
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| **Total attendance time of module** | 56 h |
inf336 - Application Area Automotive

Module name: Application Area Automotive
Module code: inf336
ECTS credit points: 6.0 KP
Workload: 180 h

Used in degree programmes:
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

Contact person:
- module responsibility: Frank Köster
- authorized examiners: Die im Modul Lehrenden

Prerequisites:

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

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

Recommended reading:

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| Total attendance time of module | 56 h |
### inf522 - Information Processing in Bio-Medical Research

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• Master Engineering of Socio-Technical Systems > Human-Computer Interaction  
• Master Engineering of Socio-Technical Systems > Systems Engineering  
• Master Informatik > Mastermodule |

**Contact person**
- module responsibility
  - Rainer Röhrig
  - Die im Modul Lehrenden
- authorized examiners
  - Die im Modul Lehrenden

**Prerequisites**

**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>
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inf523 - Medical Software Engineering

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<td>Rainer Röhrig</td>
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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.

Recommended reading

Links

Languages of instruction German, English

Duration (semesters) 1 semester

Module frequency once a year
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| Total attendance time of module | 56 h |
inf532 - Introduction to Cognitive Engineering

Module name  Introduction to Cognitive Engineering
Module code  inf532
ECTS credit points  6.0 KP
Workload  180 h
Used in degree programmes  • Master Engineering of Socio-Technical Systems > Human-Computer Interaction

Contact person
module responsibility
- Sebastian Feuerstack
- Die im Modul Lehrenden

authorized examiners
- Sebastian Feuerstack
- Die im Modul Lehrenden

Prerequisites

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 modelling 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.

Recommended reading
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)
**Links**

- 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)

<table>
<thead>
<tr>
<th>Language of instruction</th>
<th>English</th>
</tr>
</thead>
<tbody>
<tr>
<td>Duration (semesters)</td>
<td>1 semester</td>
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<tr>
<td>Module frequency</td>
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<td>Module capacity</td>
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<td>Modullevel</td>
<td>AC (Aufbaucurriculum / Composition)</td>
</tr>
<tr>
<td>Modulart</td>
<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
</tr>
<tr>
<td>Lern-/Lehrform / Type of program</td>
<td>V+Ü</td>
</tr>
</tbody>
</table>

**Vorkenntnisse / Previous knowledge**

- Helpful previous knowledge:
  - Fundamental Competences in Psychology I
  - Fundamental Competences in Psychology III
  - Applied Cognitive Psychology
  - Human Computer Interaction

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

**Examination**

<table>
<thead>
<tr>
<th>Final exam of module</th>
<th>examination periods</th>
<th>Type of examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>At the end of the lecture period</td>
<td>oral exam</td>
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**Course type**

<table>
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<tr>
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<th>Exercises</th>
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<td>2</td>
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</table>

**Total attendance time of module**

| 56 h |
inf537 - Intelligent Systems

Module name: Intelligent Systems
Module code: inf537
ECTS credit points: 6.0 KP
Workload: 180 h

Used in degree programmes:
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule
- Master Wirtschaftsinformatik > Akzentsetzungsmodule Bereich Wirtschaftsinformatik

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

Prerequisites

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.

Recommended reading
Suggested reading:
- Ghallab/ Nau/Traverso: Automated Planning, Morgan Kaufman, 2004

Links
Languages of instruction: German, English
Duration (semesters): 1 semester
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<th><strong>Module frequency</strong></th>
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<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
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<td><strong>Vorkenntnisse / Previous knowledge</strong></td>
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<td><strong>Examination</strong></td>
<td>examination periods</td>
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<td><strong>Final exam of module</strong></td>
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<td>Exercises</td>
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<td><strong>Total attendance time of module</strong></td>
<td>56 h</td>
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</table>
inf650 - Transport Systems

Module name: Transport Systems
Module code: inf650
ECTS credit points: 6.0 KP
Workload: 180 h

Used in degree programmes:
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule
- Master Wirtschaftsinformatik > Akzentsetzungsmodule Bereich Wirtschaftsinformatik

Contact person:
- module responsibility: Axel Hahn
- authorized examiners:
  - Axel Hahn
  - Die im Modul Lehrenden

Prerequisites:

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

Recommended reading:
Suggested reading:
<table>
<thead>
<tr>
<th><strong>Links</strong></th>
<th><a href="http://wi-ol.de">http://wi-ol.de</a></th>
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<td>je nach Studiengang Pflicht oder Wahlpflicht</td>
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<td><strong>Lern-/Lehrform / Type of program</strong></td>
<td>V+Ü</td>
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<td><strong>Examination</strong></td>
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<td><strong>Course type</strong></td>
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Embedded Brain Computer Interaction

inf100 - Human Computer Interaction

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<td>Workload</td>
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<td>Used in degree programmes</td>
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<td>Master Engineering of Socio-Technical Systems &gt; Embedded Brain Computer Interaction</td>
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<td>Master Wirtschaftsinformatik &gt; Bereichswahlmodule</td>
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Contact person

module responsibility

- Susanne Boll-Westermann
- Die im Modul Lehrenden

authorized examiners

- Susanne Boll-Westermann
- Die im Modul Lehrenden

Prerequisites

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.

Recommended reading

- 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

Language of instruction

German

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+P

### Vorkenntnisse / Previous knowledge
Basic programming skills

### Examination

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<th>examination periods</th>
<th>Type of examination</th>
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<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>
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### Course type

<table>
<thead>
<tr>
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<th>Comment</th>
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<tr>
<td>Practical</td>
<td>2</td>
<td></td>
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<td>28 h</td>
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### Total attendance time of module

56 h
inf300 - Hybrid Systems

Module name: Hybrid Systems
Module code: inf300
ECTS credit points: 6.0 KP
Workload: 180 h

Used in degree programmes:
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodule
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Informatik > Mastermodule

Contact person
module responsibility
- Martin Georg Fränzle

Authorized examiners
- Martin Georg Fränzle
- Die im Modul Lehrenden

Prerequisites:
A BSc in CS with a specialisation equivalent to "embedded systems and microrobotics" or corresponding knowledge from the MSc. The lecture assumes familiarity with the modelling and analysis of reactive systems.

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:
Content of the Module: 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.

Recommended reading
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
A BSc. in CS or knowledge of ordinary differential

Examination

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<th>Final exam of module</th>
<th>examination periods</th>
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Course type

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Total attendance time of module
56 h
inf301 - Machine-oriented Systems Engineering

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<td>Workload</td>
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<td>▪ Master Engineering of Socio-Technical Systems &gt; Human-Computer Interaction</td>
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<tr>
<td></td>
<td>▪ Master Engineering of Socio-Technical Systems &gt; Systems Engineering</td>
</tr>
<tr>
<td></td>
<td>▪ Master Informatik &gt; Mastermodule</td>
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<tr>
<td>Contact person</td>
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<tr>
<td></td>
<td>module responsibility</td>
</tr>
<tr>
<td></td>
<td>▪ Alfred Mikschl</td>
</tr>
<tr>
<td></td>
<td>▪ Werner Damm</td>
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<tr>
<td></td>
<td>authorized examiners</td>
</tr>
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<td></td>
<td>▪ Die im Modul Lehrenden</td>
</tr>
<tr>
<td>Prerequisites</td>
<td></td>
</tr>
<tr>
<td>Skills to be acquired in this module</td>
<td>The module provides practical relevance to the design of digital embedded systems.</td>
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<tr>
<td></td>
<td>Professional competence</td>
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<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>▪ characterise the structure of microprocessor systems</td>
</tr>
<tr>
<td></td>
<td>▪ name control aspects of time sensitive external components</td>
</tr>
<tr>
<td></td>
<td>▪ program efficient embedded systems</td>
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<tr>
<td></td>
<td>Methodological competence</td>
</tr>
<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>▪ use specifications from electrical components data sheets</td>
</tr>
<tr>
<td></td>
<td>Social competence</td>
</tr>
<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>▪ work in a team</td>
</tr>
<tr>
<td></td>
<td>▪ discuss solutions</td>
</tr>
<tr>
<td>Module contents</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
<tr>
<td>Recommended reading</td>
<td>Lecturers notes, hardware manuals and data sheets, and development tool manuals</td>
</tr>
<tr>
<td>Links</td>
<td></td>
</tr>
<tr>
<td>Languages of instruction</td>
<td>German, English</td>
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<td>Duration (semesters)</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+P</td>
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<td>Vorkenntnisse / Previous knowledge</td>
<td>„Eingebettete Systeme I and II“and successful completion of the module „Praktikum Technische Informatik“</td>
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<tr>
<td>Examination</td>
<td>examination periods</td>
</tr>
<tr>
<td>Type of examination</td>
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<tr>
<td>Final exam of module</td>
<td>At the end of the lecture period</td>
</tr>
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</table>
of embedded systems, colloquium)

<table>
<thead>
<tr>
<th>Course type</th>
<th>Comment</th>
<th>SWS</th>
<th>Offer rhythm</th>
<th>Workload attendance</th>
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<tr>
<td>Lecture</td>
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<td>2</td>
<td></td>
<td>28 h</td>
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<tr>
<td>Practical</td>
<td></td>
<td>2</td>
<td></td>
<td>28 h</td>
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**Total attendance time of module** 56 h
inf303 - Fuzzy Control and Artificial Neural Networks in Robotics and Automation

Module name: Fuzzy Control and Artificial Neural Networks in Robotics and Automation
Module code: inf303
ECTS credit points: 6.0 KP
Workload: 180 h

Used in degree programmes:
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodule
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

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

Prerequisites:
- Sergej Fatikow
- Die im Modul Lehrenden

Skills to be acquired in this module:
Experts in different branches try to approach their application-specific control and information processing problems by using fuzzy logic and artificial neural networks (ANN). The experiences gathered up to now prove robotics and automation technology to be predestined fields of application of both these approaches. The major topics of the course are control problems in robotics and automation technology, principles of fuzzy logic and ANN and their practical applications, comparison of conventional and advanced control methods, combination of fuzzy logic and ANN in control systems. The course gives a comprehensive treatment of these advanced approaches for interested students.

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

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

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

Objective of the module / skills:

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

Module contents:
- Control problems in robotics and automation technology
- Basic ideas of fuzzy logic and ANN
- Principles of fuzzy logic
- Fuzzy logic of rule-based systems
- ANN models
- ANN learning rules
Recommended reading

**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, Systhema 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
- Zimmermann H.-J. (Hrsg.): Datenaalysese, VDI-Verlag, 1995
<table>
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inf305 - Medical Technology

**Module name**
Medical Technology

**Module code**
inf305

**ECTS credit points**
6.0 KP

**Workload**
180 h

**Used in degree programmes**
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodule
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

**Contact person**
module responsibility
- Andreas Hein
- Die im Modul Lehrenden

authorized examiners
- Die im Modul Lehrenden
- Andreas Hein

**Prerequisites**

**Skills to be acquired in this module**

**Professional competence**
The students:

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

**Methodological competence**
The students:

- Recognise the interdisciplinary challenges and accordingly exchange information with other disciplines

**Social competence**
The students:

- Present solutions for specific questions

**Self-competence**
The students:

- reflect their solutions by using methods learned in this course

**Module contents**

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

**Recommended reading**

**essential:**
- Lecture slides

**recommended:**
secondary literature:

inf307 - Robotics

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**Used in degree programmes**
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodule
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

**Contact person**
- module responsibility
  - Andreas Hein
  - Die im Modul Lehrenden
- authorized examiners
  - Die im Modul Lehrenden

**Prerequisites**

**Skills to be acquired in this module**

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

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

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

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

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

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

- Actuators

**Recommended reading**

**essential:**
lecture nodes

**recommended:**

**secondary literature:**

**Links**

**Languages of instruction**
German, English

**Duration (semesters)**
1 semester

**Module frequency**
one 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**

**examination periods**
at the end of the lecture periode

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

**Final exam of module**

**Course type**

**Comment**

**SWS**

**Offer rhythm**

**Workload attendance**

Lecture
3
42 h

Exercises
1
14 h

**Total attendance time of module**
56 h
inf308 - Microrobotics II

Module name: Microrobotics II
Module code: inf308
ECTS credit points: 6.0 KP
Workload: 180 h
Used in degree programmes:
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodule
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

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

Prerequisites:

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

Professional competence
The students:
- Name and recognise the basic concepts of nanotechnology, in particular, micro- and nanorobotics approaches
- Differentiate the development, control and application of micro- and nanorobotics systems
- Implement and design application-specific micro- and nanorobotics systems

Methodological competence
The students:
- Transfer their control engineering and image processing abilities on interdisciplinary problems
- Transfer their hands-on experience to develop controls and applications of microrobotic systems on new tasks

Social competence
The students:
- Work in a team

Self-competence
The students:
- Reflect their problem-solving behaviour and use hands-on experience to develop, control and application of microrobotics

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

Recommended reading:
- Lecture notes (can be obtained in our secretariate, A1-3-303)

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inf311 - Low Energy System Design

Module name: Low Energy System Design
Module code: inf311
ECTS credit points: 6.0 KP
Workload: 180 h

Used in degree programmes:
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodule
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

Contact person:
module responsibility: Wolfgang Nebel
authorized examiners: Die im Modul Lehrenden

Prerequisites:

Skills to be acquired in this module:

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

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

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

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

Module contents
According to Moore’s Law the number of integratable transistors on a computer chip doubles every two years. In addition, new circuits are getting faster and faster. This leads not only to an increased functionality of a system, but it also increases the electrical power consumption.

This electrical power consumption is problematic from two different points of view: Firstly, the electrical power must be supplied. Secondly, the resulting heat has to dissipate from the system. An increased power consumption always causes lower battery life and higher energy costs. The heat generation reduces the reliability and life of integrated circuits. The cooling (ceramic housings, cooling elements, fans, etc.) increases the system’s costs.

Today the development of heat, caused by power dissipation, needs to be considered during the embedded system design process. This knowledge takes the system’s reliability and operation costs into account.

This module introduces the estimation of power dissipation and optimisation.

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

### Links
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| Vorkenntnisse / Previous knowledge | - inf200 Grundlagen der Technische Informatik,  
- inf201 Technische Informatik,  
- inf203 Eingebettete Systeme I+,  
- inf204 Eingebettete Systeme II |

### Examination
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### Total attendance time of module
| Total attendance time of module | 56 h |
inf331 - Automated and Connected Driving

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| Used in degree programmes | • Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction  
                          | • Master Informatik > Mastermodule |
| Contact person       | module responsibility           |
|                      | • Frank Köster                 |
|                      | • Die im Modul Lehrenden        |

Prerequisites

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

Recommended reading

Suggested reading:

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inf332 - Practice Robotics

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| Used in degree programmes | • Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction  
                          | • Master Informatik > Mastermodule                    |
| Contact person         | module responsibility                                  |
|                        | • Andreas Hein                                        |
|                        | • Die im Modul Lehrenden                              |
| authorized examiners   | • Die im Modul Lehrenden                              |

Prerequisites

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.

Recommended reading

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 unlimited
Module level AS (Akzentsetzung / Accentuation)
Modulart Pflicht o. Wahlpflicht / compulsory or optional
Lern-/Lehrform / Type of program V+Ü

Vorkenntnisse / Previous knowledge

Examination examination periods Type of examination
Final exam of module at the end of the lecture period Demonstration and written documentation
Course type Comment SWS Offer rhythm Workload attendance
Lecture 2 SunSem and WinSem 28 h
Exercises 2 SunSem and WinSem 28 h
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**inf333 - Sensor Technology in the Automotive Domain**

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| Used in degree programmes  | Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction  
|                        | Master Engineering of Socio-Technical Systems > Human-Computer Interaction  
|                        | Master Engineering of Socio-Technical Systems > Systems Engineering  
|                        | Master Informatik > Mastermodule           |

**Contact person**

module responsibility

- Frank Köster  
- Die im Modul Lehrenden

authorized examiners

- Die im Modul Lehrenden

**Prerequisites**

**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 car2x-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
- Car2x-technologies (ITS G5 and 5G)
- Multi-sensor and multi-level fusion architectures

**Recommended reading**

### Links

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### Examination

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### Total attendance time of module

56 h
inf334 - System Level Design

Module name: System Level Design
Module code: inf334
ECTS credit points: 6.0 KP
Workload: 180 h

Used in degree programmes:
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

Contact person:
- module responsibility
  - Kim Grüttner
  - Die im Modul Lehrenden
- authorized examiners
  - Die im Modul Lehrenden

Prerequisites:

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 of 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.

Recommended reading

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)

Modulart

Pflicht o. Wahlpflicht / compulsory or optional

Lern-Lehrform / Type of program

V+Ü

Vorkenntnisse / Previous knowledge

- inf200 Grundlagen der Technische Informatik,
- inf201 Technische Informatik,
- inf203 Eingebettete Systeme I,
- inf204 Eingebettete Systeme II

Examination

examination periods

Type of examination

Final exam of module at the end of the lecture period hands-on exercises and oral exam

Course type

Comment

SWS

Offer rhythm

Workload attendance

Lecture

2

SunSem and WinSem

28 h

Exercises

2

SunSem and WinSem

28 h

Total attendance time of module

56 h
inf335 - Strategy Synthesis

Module name: Strategy Synthesis
Module code: inf335
ECTS credit points: 6.0 KP
Workload: 180 h

Used in degree programmes:
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Informatik > Mastermodule

Contact person:
- module responsibility: Werner Damm
- Die im Modul Lehrenden
- authorized examiners: Die im Modul Lehrenden

Prerequisites:

Skills to be acquired in this module:
The students learn fundamental techniques in strategy synthesis as foundation for high-level control strategies in highly autonomous systems

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.

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


**Links**

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<td>A BSc. in CS with a specialisation equivalent to &quot;embedded systems and microrobotics&quot; or corresponding knowledge from the MSc: The lecture assumes familiarity with the modelling and analysis of reactive systems.</td>
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inf336 - Application Area Automotive

**Module name**
Application Area Automotive

**Module code**
inf336

**ECTS credit points**
6.0 KP

**Workload**
180 h

**Used in degree programmes**
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

**Contact person**
module responsibility
- Frank Köster
authorized examiners
- Die im Modul Lehrenden

**Prerequisites**

**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

**Recommended reading**

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| **Voraussetzungen / Previous knowledge** | |
| Exam | **SWS** |
| Final exam of module | At the end of the lecture period |
| Practical Work and oral Exam |  |
| Course type | Comment |
| Lecture | 2 |
| Exercises | 2 |
| Offer rhythm | SunSem and WinSem |
| Workload attendance | 28 h |

| **Type of examination** | **SWS** |
| Total attendance time of module | 56 h |
inf338 - Design of Autonomous Systems

Module name: Design of Autonomous Systems
Module code: inf338
ECTS credit points: 6.0 KP
Workload: 180 h

Used in degree programmes:
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Informatik > Mastermodule

Contact person:
- module responsibility: Martin Georg Fränzle
- authorized examiners: Die im Modul Lehrenden

Prerequisites:
- 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.

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 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

Recommended reading

Links

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+U

Examination

Vorkenntnisse / Previous knowledge

Type of examination:
- examination periods: Second half of semester
- Final exam of module: Presentation
- Course type: Lecture
- SWS: 2
- Offer rhythm: SunSem and WinSem
- Workload attendance: 28 h
- Course type: Exercises
- SWS: 2
- Offer rhythm: SunSem and WinSem
- Workload attendance: 28 h

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

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## Used in degree programmes
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodule
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

## Contact person
- module responsibility
  - Ernst-Rüdiger Olderog
  - Die im Modul Lehrenden

- authorized examiners
  - Die im Modul Lehrenden

## Prerequisites

## 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 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

Recommended reading

essential:


recommended:


Links

Languages of instruction | German, English
Duration (semesters) | 1 semester
Module frequency | irregular
Module capacity | unlimited
Module level | AS (Akzentsetzung / Accentuation)
Modulart | Pflicht o. Wahlpflicht / compulsory or optional
Lern-/Lehrform / Type of program | V+Ü
Vorkenntnisse / Previous knowledge | Theoretical Computer Science I and II

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

<table>
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<td>14 h</td>
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Total attendance time of module | 56 h
inf460 - Security

Module name  Security  
Module code inf460  
ECTS credit points  6.0 KP  
Workload  180 h  

Used in degree programmes
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

Contact person
module responsibility
- Sibylle Fröschle

authorized examiners
- Die im Modul Lehrenden

Prerequisites

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.

Recommended reading
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<td>Lern-/Lehrform / Type of program</td>
<td>V+Ü</td>
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inf522 - Information Processing in Bio-Medical Research

Module name  Information Processing in Bio-Medical Research
Module code  inf522
ECTS credit points  6.0 KP
Workload  180 h

Used in degree programmes
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

Contact person
module responsibility
- Rainer Röhrig

authorized examiners
- Die im Modul Lehrenden

Prerequisites
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
### Recommended reading

### Links

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### Examination

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<th>Type of examination</th>
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### Course type

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### Total attendance time of module

28 h
inf523 - Medical Software Engineering

Module name: Medical Software Engineering
Module code: inf523
ECTS credit points: 6.0 KP
Workload: 180 h

Used in degree programmes:
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

Contact person:
- module responsibility
  - Rainer Röhrig
- Die im Modul Lehrenden
- authorized examiners
  - Die im Modul Lehrenden

Prerequisites:

Skills to be acquired in this module:

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.

Recommended reading

Links

Languages of instruction: German, English
Duration (semesters): 1 semester
Module frequency: once a year
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**Total attendance time of module** 56 h
inf536 - Computational Intelligence II

Module name                Computational Intelligence II
Module code                inf536
ECTS credit points         6.0 KP
Workload                   180 h

Used in degree programmes
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Informatik > Mastermodule

Contact person
module responsibility
- Oliver Kramer

authorized examiners
- Die im Modul Lehrenden

Prerequisites

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

Recommended reading
- HASTIE, T., TIBSHIRANI, R., FRIEDMAN, J.H.: The Elements of Statistical Learning, Springer 2009
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| Total attendance time of module | 56 h   |
inf537 - Intelligent Systems

Module name  
Intelligent Systems

Module code  
inf537

ECTS credit points  
6.0 KP

Workload  
180 h

Used in degree programmes
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule
- Master Wirtschaftsinformatik > Akzentsetzungsmodul Bereich Wirtschaftsinformatik

Contact person

module responsibility
- Jürgen Sauer

Module counseling
- Die im Modul Lehrenden

Prerequisites

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.

Recommended reading
Suggested reading:
- Ghalbab/ Nau/ Traverso: Automated Planning, Morgan Kaufman, 2004

Links

Languages of instruction  
German, English

Duration (semesters)  
1 semester
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inf650 - Transport Systems

Module name: Transport Systems
Module code: inf650
ECTS credit points: 6.0 KP
Workload: 180 h

Used in degree programmes:
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule
- Master Wirtschaftsinformatik > Akzentsetzungsmodule Bereich Wirtschaftsinformatik

Contact person:
- module responsibility: Axel Hahn
- authorized examiners: Axel Hahn, Die im Modul Lehrenden

Prerequisites:

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

Recommended reading:
Suggested reading:
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<th><a href="http://wi-ol.de">http://wi-ol.de</a></th>
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inf973 - Psychological practicum fNIRS, EEG

Module name: Psychological practicum fNIRS, EEG
Module code: inf973
ECTS credit points: 6.0 KP
Workload: 180 h
Used in degree programmes:
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction

Contact person:
module responsibility
- Jochem Rieger
authorized examiners
- Jochem Rieger
- Die im Modul Lehrenden

Prerequisites:

Skills to be acquired in this module:

Professional competences:
The students:
- will acquire Knowledge of planning, performing, and analysis of a neurocognitive study

Methodological competences:
The students:
- learn to arrange a scientific report
- be taught in the methods of psychophysiology, e.g. EEG, MEG, fMRI, or fNIRS

Social competences:
The students:
- will work within a team

Self-competences:
The students:
- will have to apply time management

Module contents:
The module consists of a practical part.
The students will obtain knowledge of literature search, comprehension of scientific texts. They will acquire skills in conducting experimental research.

Recommended reading:

Links:

Language of instruction: English
Duration (semesters): 1 semester
Module frequency: once a year
Module capacity: 6
Modullevel: AS (Akzentsetzung / Accentuation)
Modulart: Wahlpflicht / Elective
Lern-/Lehrform / Type of program: P

Vorkenntnisse / Previous knowledge:

Examination examination periods Type of examination
Final exam of module At the end of the semester Presentation
inf974 - Human Computer Interaction and Brain Computer Interfacing

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<td>- Jochem Rieger</td>
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<td>- Andreas Lüdtke</td>
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Contact person

Authorized examiners

- Die im Modul Lehrenden

Prerequisites

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.

Recommended reading


Links

Language of instruction | English |
Duration (semesters)    | 2 semester |
Module frequency        | once a year |
Module capacity         | unlimited |
Information             | The module will start every summer term with part 1. Part 2 will be offered in the winter term. |
Modullevel              | AS (Akzentsetzung / Accentuation) |
Modulart                | Pflicht o. Wahlpflicht / compulsory or optional |
Lern-/Lehrform / Type of program | V+TPS |
Vorkenntnisse / Previous knowledge | Knowledge in statistical data analysis techniques and/or programming (e.g. Module N) is desirable |
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Systems Engineering

**inf301 - Machine-oriented Systems Engineering**

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**Use in degree programmes**
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodule
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

**Contact person**
- module responsibility
  - Alfred Mikschl
  - Werner Damm
- authorized examiners
  - Die im Modul Lehrenden

**Prerequisites**

**Skills to be acquired in this module**
The module provides practical relevance to the design of digital embedded systems.

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

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

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

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

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

**Recommended reading**
Lecturers notes, hardware manuals and data sheets, and development tool manuals

**Languages of instruction**
German, English

**Duration (semesters)**
1 semester

**Module frequency**
semi-anual

**Module capacity**
unlimited

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

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

**Lern-/Lehrform / Type of program**
V+P
### Vorkenntnisse / Previous knowledge

„Eingebettete Systeme I and II“ and successful completion of the module „Praktikum Technische Informatik“

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

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<td>- Master Informatik &gt; Mastermodule</td>
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<td></td>
<td>- Sergej Fatikow</td>
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<td>- Sergej Fatikow</td>
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**Prerequisites**

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

Recommended reading

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, Systhema 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. Ladewig-Riebler, P. und Thoer, St.: Neuronale Netze für Ingenieure, Vieweg, Wiesbaden, 1998
- Zimmermann H.-J. (Hrsg.): Datenanalyse, VDI-Verlag, 1995

Links

Languages of instruction

German, English

Duration (semesters)

1 semester

Module frequency

once a year

Module capacity

unlimited

Module level

AS (Akzentsetzung / Accentuation)

Modulart

Pflicht o. Wahlpflicht / compulsory or optional

Vorkenntnisse / Previous knowledge

Control engineering

Examination

examination periods

Type of examination

Final exam of module
At the end of the lecture period until the beginning of the next semester

Hands-on-exercises and oral Exam

Course type

Comment

SWS

Offer rhythm

Workload attendance

Lecture

3

42 h
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**Contact person**

- module responsibility
  - Andreas Hein
  - Die im Modul Lehrenden

- authorized examiners
  - Die im Modul Lehrenden
  - Andreas Hein

**Prerequisites**

**Skills to be acquired in this module**

**Professional competence**

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

**Methodological competence**

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

**Social competence**

- The students:
  - Present solutions for specific questions

**Self-competence**

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

**Module contents**

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

**Recommended reading**

**essential:**

- Lecture slides

**recommended:**

- 

---
secondary literature:


Links

<table>
<thead>
<tr>
<th>Languages of instruction</th>
<th>German, English</th>
</tr>
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<tbody>
<tr>
<td>Duration (semesters)</td>
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</tr>
<tr>
<td>Module frequency</td>
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</tr>
<tr>
<td>Module capacity</td>
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</tr>
<tr>
<td>Module level</td>
<td>AS (Akzentsetzung / Accentuation)</td>
</tr>
<tr>
<td>Modulart</td>
<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
</tr>
<tr>
<td>Lern-/Lehrform / Type of program</td>
<td>V+Ü</td>
</tr>
<tr>
<td>Vorkenntnisse / Previous knowledge</td>
<td>Signal and Image Processing, Control Engineering</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Examination</th>
<th>examination periods</th>
<th>Type of examination</th>
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<tbody>
<tr>
<td>Final exam of module</td>
<td>At the end of the lecture period</td>
<td>Portfolio: Hands-on exercises, report, and written or oral exam</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Course type</th>
<th>Comment</th>
<th>SWS</th>
<th>Offer rhythm</th>
<th>Workload attendance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td></td>
<td>3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Exercises</td>
<td></td>
<td>1</td>
<td></td>
<td></td>
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</table>

Total attendance time of module 56 h
inf307 - Robotics

Module name  Robotics
Module code  inf307
ECTS credit points  6.0 KP
Workload  180 h

Used in degree programmes
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodule
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

Contact person
module responsibility
- Andreas Hein
- Die im Modul Lehrenden

Contact person
authorized examiners
- Die im Modul Lehrenden

Prerequisites

Skills to be acquired in this module

<table>
<thead>
<tr>
<th>Professional competence</th>
</tr>
</thead>
<tbody>
<tr>
<td>The students:</td>
</tr>
<tr>
<td>- Name and know the functions and applications of robot systems</td>
</tr>
<tr>
<td>- Characterise the basic concepts to program robot systems</td>
</tr>
<tr>
<td>- Differentiate between the interaction of mechanical, electrical and software components</td>
</tr>
</tbody>
</table>

Methodological competence

<table>
<thead>
<tr>
<th>The students:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Define characteristics and components of robot systems for a specific application</td>
</tr>
<tr>
<td>- Design and implement robot system sub-components</td>
</tr>
<tr>
<td>- Design and parameterise simple control structures</td>
</tr>
<tr>
<td>- Plan the application of robot systems and derive the requirements</td>
</tr>
<tr>
<td>- Model electrical and mechanical systems</td>
</tr>
<tr>
<td>- Develop and realise simple robot systems</td>
</tr>
</tbody>
</table>

Social competence

<table>
<thead>
<tr>
<th>The students:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Solve robot systems problems in team work</td>
</tr>
</tbody>
</table>

Self-competence

<table>
<thead>
<tr>
<th>The students:</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Reflect their solutions in reference to robot system methods</td>
</tr>
</tbody>
</table>

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

Recommended reading

**essential:**
lecture nodes

**recommended:**

**secondary literature:**

Links

Languages of instruction
German, 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

examination periods
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
Comment
SWS
Offer rhythm
Workload attendance

Lecture
3
42 h

Exercises
1
14 h

Total attendance time of module
56 h
**inf308 - Microrobotics II**

<table>
<thead>
<tr>
<th>Module name</th>
<th>Microrobotics II</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module code</td>
<td>inf308</td>
</tr>
<tr>
<td>ECTS credit points</td>
<td>6.0 KP</td>
</tr>
<tr>
<td>Workload</td>
<td>180 h</td>
</tr>
<tr>
<td>Used in degree programmes</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Master Eingebettete Systeme und Mikrorobotik &gt; Akzentsetzungsmodule</td>
</tr>
<tr>
<td></td>
<td>Master Engineering of Socio-Technical Systems &gt; Embedded Brain Computer Interaction</td>
</tr>
<tr>
<td></td>
<td>Master Engineering of Socio-Technical Systems &gt; Human-Computer Interaction</td>
</tr>
<tr>
<td></td>
<td>Master Engineering of Socio-Technical Systems &gt; Systems Engineering</td>
</tr>
<tr>
<td></td>
<td>Master Informatik &gt; Mastermodule</td>
</tr>
<tr>
<td>Contact person</td>
<td>module responsibility</td>
</tr>
<tr>
<td></td>
<td>Sergej Fatikow</td>
</tr>
<tr>
<td></td>
<td>Die im Modul Lehrenden</td>
</tr>
<tr>
<td>Prerequisites</td>
<td></td>
</tr>
<tr>
<td>Skills to be acquired in this module</td>
<td>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.</td>
</tr>
<tr>
<td>Professional competence</td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>Name and recognise the basic concepts of nanotechnology, in particular, micro- and nanorobotics approaches</td>
</tr>
<tr>
<td></td>
<td>Differentiate the development, control and application of micro- and nanorobotics systems</td>
</tr>
<tr>
<td></td>
<td>Implement and design application-specific micro- and nanorobotics systems</td>
</tr>
<tr>
<td>Methodological competence</td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>Transfer their control engineering and image processing abilities on interdisciplinary problems</td>
</tr>
<tr>
<td></td>
<td>Transfer their hands-on experience to develop controls and applications of microrobotic systems on new tasks</td>
</tr>
<tr>
<td>Social competence</td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>Work in a team</td>
</tr>
<tr>
<td>Self-competence</td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>Reflect their problem-solving behaviour and use hands-on experience to develop, control and application of microrobotics</td>
</tr>
<tr>
<td>Module contents</td>
<td>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</td>
</tr>
<tr>
<td>Recommended reading</td>
<td>Lecture notes (can be obtained in our secretariate, A1-3-303)</td>
</tr>
</tbody>
</table>

**Links**
<table>
<thead>
<tr>
<th><strong>Languages of instruction</strong></th>
<th>German, English</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Duration (semesters)</strong></td>
<td>1 semester</td>
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<tr>
<td><strong>Module frequency</strong></td>
<td>once a year</td>
</tr>
<tr>
<td><strong>Module capacity</strong></td>
<td>unlimited</td>
</tr>
<tr>
<td><strong>Module level</strong></td>
<td>AS (Akzentsetzung / Accentuation)</td>
</tr>
<tr>
<td><strong>Modulart</strong></td>
<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
</tr>
<tr>
<td><strong>Lern-/Lehrform / Type of program</strong></td>
<td>V+Ü</td>
</tr>
<tr>
<td><strong>Vorkenntnisse / Previous knowledge</strong></td>
<td>Module Microrobotics and Microsystem Technology</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th><strong>Examination</strong></th>
<th><strong>examination periods</strong></th>
<th><strong>Type of examination</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Final exam of module</strong></td>
<td>At the end of the lecture period</td>
<td>Oral Exam and exercises</td>
</tr>
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</table>

**Course type** | **Comment** | **SWS** | **Offer rhythm** | **Workload attendance**
--- | --- | --- | --- | ---
Lecture | 3 | | | 42 h |
Exercises | 1 | | | 14 h |

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

Module name: Low Energy System Design
Module code: inf311
ECTS credit points: 6.0 KP
Workload: 180 h

Used in degree programmes:
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodule
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

Contact person:
- module responsibility: Wolfgang Nebel
- authorized examiners: Die im Modul Lehrenden

Prerequisites:

Skills to be acquired in this module:

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

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

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

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

Module contents:
According to Moore’s Law the number of integratable transistors on a computer chip doubles every two years. In addition, new circuits are getting faster and faster. This leads not only to an increased functionality of a system, but it also increases the electrical power consumption.

This electrical power consumption is problematic from two different points of view: Firstly, the electrical power must be supplied. Secondly, the resulting heat has to dissipate from the system. An increased power consumption always causes lower battery life and higher energy costs. The heat generation reduces the reliability and life of integrated circuits. The cooling (ceramic housings, cooling elements, fans, etc.) increases the system’s costs.

Today the development of heat, caused by power dissipation, needs to be considered during the embedded system design process. This knowledge takes the system’s reliability and operation costs into account.

This module introduces the estimation of power dissipation and optimisation.

Recommended reading:
- Designing CMOS Circuits for Low Power – Dimitros Soudris, Christian Piguet, Costas Goutis
- 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

<table>
<thead>
<tr>
<th>Links</th>
</tr>
</thead>
<tbody>
<tr>
<td>Languages of instruction</td>
</tr>
<tr>
<td>Duration (semesters)</td>
</tr>
<tr>
<td>Module frequency</td>
</tr>
<tr>
<td>Module capacity</td>
</tr>
<tr>
<td>Modullevel</td>
</tr>
<tr>
<td>Modulart</td>
</tr>
<tr>
<td>Lern-/Lehrform / Type of program</td>
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</table>
| Vorkenntnisse / Previous knowledge | - inf200 Grundlagen der Technische Informatik,  
- inf201 Technische Informatik,  
- inf203 Eingebettete Systeme I,  
- inf204 Eingebettete Systeme II |
| Examination | |
| Course type | examination periods | Type of examination |
| Final exam of module | at the end of the lecture period | hands-on exercises and oral exam |
| Lecture | 3 | SWS |
| Exercises | 1 | Offer rhythm |
| Total attendance time of module | 56 h | Workload attendance |

<table>
<thead>
<tr>
<th>Workload attendance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
</tr>
<tr>
<td>Exercises</td>
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</tbody>
</table>
inf333 - Sensor Technology in the Automotive Domain

**Module name**  
Sensor Technology in the Automotive Domain

**Module code**  
inf333

**ECTS credit points**  
6.0 KP

**Workload**  
180 h

**Used in degree programmes**
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

**Contact person**

module responsibility
- Frank Köster

authorized examiners
- Die im Modul Lehrenden

**Prerequisites**

**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 car2x-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
- Car2x-technologies (ITS G5 and 5G)
- Multi-sensor and multi-level fusion architectures

**Recommended reading**

**Suggested reading:**

### Links

<table>
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<tr>
<th>Language of instruction</th>
<th>English</th>
</tr>
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<tbody>
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<td>Duration (semesters)</td>
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<td>Module frequency</td>
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</tr>
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<td>Module capacity</td>
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<td>Module level</td>
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</tr>
<tr>
<td>Modulart</td>
<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
</tr>
<tr>
<td>Lern-/Lehrform / Type of program</td>
<td>V+Ü</td>
</tr>
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</table>

### Vorkenntnisse / Previous knowledge

### Examination

<table>
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<tr>
<th>Examination</th>
<th>examination periods</th>
<th>Type of examination</th>
</tr>
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<tbody>
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<td>Final exam of module</td>
<td>At the end of the lecture period</td>
<td>Practical Work and oral exam</td>
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<table>
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<tr>
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<th>SWS</th>
<th>Offer rhythm</th>
<th>Workload attendance</th>
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</thead>
<tbody>
<tr>
<td>Lecture</td>
<td>2</td>
<td>SunSem and WinSem</td>
<td>28 h</td>
<td></td>
</tr>
<tr>
<td>Exercises</td>
<td>2</td>
<td>SunSem and WinSem</td>
<td>28 h</td>
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</table>

### Total attendance time of module

56 h
inf334 - System Level Design

Module name: System Level Design
Module code: inf334
ECTS credit points: 6.0 KP
Workload: 180 h

Used in degree programmes:
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

Contact person:
- module responsibility
  - Kim Grüttner
- authorized examiners
  - Die im Modul Lehrenden

Prerequisites

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 of 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.

### Recommended reading

**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/](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

### Module level

AS (Akzentsetzung / Accentuation)

### Modulart

Pflicht o. Wahlpflicht / compulsory or optional

### Lern-/Lehrform / Type of program

V+Ü

### Vorkenntnisse / Previous knowledge

- inf200 Grundlagen der Technische Informatik,
- inf201 Technische Informatik,
- inf203 Eingebettete Systeme I,
- inf204 Eingebettete Systeme II

### Examination

- Final exam of module at the end of the lecture period
- Hands-on exercises and oral exam

### Course type

<table>
<thead>
<tr>
<th>Course type</th>
<th>Examination periods</th>
<th>Type of examination</th>
<th>SWS</th>
<th>Offer rhythm</th>
<th>Workload attendance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lecture</td>
<td></td>
<td>hands-on exercises and oral exam</td>
<td>2</td>
<td>SumSem and WinSem</td>
<td>28 h</td>
</tr>
<tr>
<td>Exercises</td>
<td></td>
<td></td>
<td>2</td>
<td>SumSem and WinSem</td>
<td>28 h</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>56 h</td>
</tr>
</tbody>
</table>

115 / 138
inf336 - Application Area Automotive

Module name | Application Area Automotive
--- | ---
Module code | inf336
ECTS credit points | 6.0 KP
Workload | 180 h

**Used in degree programmes**

- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

**Contact person**

- module responsibility
  - Frank Köster
  - Die im Modul Lehrenden
- authorized examiners
  - Die im Modul Lehrenden

**Prerequisites**

**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

**Recommended reading**

inf454 - Communicating and Mobile Systems

<table>
<thead>
<tr>
<th>Module name</th>
<th>Communicating and Mobile Systems</th>
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</thead>
<tbody>
<tr>
<td>Module code</td>
<td>inf454</td>
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<tr>
<td>ECTS credit points</td>
<td>6.0 KP</td>
</tr>
<tr>
<td>Workload</td>
<td>180 h</td>
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</table>
| Used in degree programmes | - Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodule  
|                     | - Master Engineering of Socio-Technical Systems > Systems Engineering  
|                     | - Master Informatik > Mastermodule |
| Contact person | module responsibility            |
|               | - Ernst-Rüdiger Olderog          |
|               | - Die im Modul Lehrenden         |
| Prerequisites |

Skills to be acquired in this module

Introduction to Milner’s Calculus of Communicating Systems (CCS) and the π-calculus.

Professional competence

The students:

- Know the theory of the operational semantics of CCS and the π-calculus
- Perform equivalence proofs using simulations and bisimulations
- Specify communicating and mobile systems with CCS and the π-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 π-calculus. It enables a new modelling of communication, taking the location of the communication into account.

The π-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 π-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 π-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 π-calculus
- proof of strong equivalence and observational equivalence of given processes
- specification of dynamic data structures in the π-calculus

**Recommended reading**


**Links**

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<thead>
<tr>
<th>Languages of instruction</th>
<th>German, English</th>
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<td>Lern-/Lehrform / Type of program</td>
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**Examination**

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**Course type**

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**Total attendance time of module**

56 h
inf456 - Real-Time Systems

Module name: Real-Time Systems
Module code: inf456
ECTS credit points: 6.0 KP
Workload: 180 h

Used in degree programmes:
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodule
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

Contact person:
- module responsibility: Ernst-Rüdiger Olderog
- authorized examiners: Die im Modul Lehrenden

Prerequisites:

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 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

Recommended reading


Recommended:


Links

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Total attendance time of module 56 h
inf460 - Security

Module name: Security
Module code: inf460
ECTS credit points: 6.0 KP
Workload: 180 h

Used in degree programmes:
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

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

Prerequisites

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.

Recommended reading

Links

- access from http://vhome.offis.de/sibylen

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inf461 - Security of Cyber-Physical Systems

Module name: Security of Cyber-Physical Systems
Module code: inf461
ECTS credit points: 6.0 KP
Workload: 180 h
Used in degree programmes:
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

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

Prerequisites:
- 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 countermeasures, 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.

Recommended reading:
Recent scientific papers and reports in the public domain news.

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

Language of instruction: English
Duration (semesters): 1 semester
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<td>Presentation and written documentation, oral exam, or exam</td>
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inf522 - Information Processing in Bio-Medical Research

Module name: Information Processing in Bio-Medical Research

Module code: inf522

ECTS credit points: 6.0 KP

Workload: 180 h

Used in degree programmes:
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

Contact person:
- module responsibility: Rainer Röhrig
- authorized examiners: Die im Modul Lehrenden

Prerequisites:

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
**Recommended reading**

**Links**

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<th>Languages of instruction</th>
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**Vorkenntnisse / Previous knowledge**

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**Total attendance time of module**

28 h
inf523 - Medical Software Engineering

Module name: Medical Software Engineering
Module code: inf523
ECTS credit points: 6.0 KP
Workload: 180 h

Used in degree programmes:
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

Contact person:
module responsibility
- Rainer Röhrig
- Die im Modul Lehrenden
authorized examiners
- Die im Modul Lehrenden

Prerequisites:

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.

Recommended reading:

Links:

Languages of instruction: German, English
Duration (semesters): 1 semester
Module frequency: once a year
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**Total attendance time of module**: 56 h
**inf533 - Probabilistic Modelling I**

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**Used in degree programmes**
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodulle
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule
- Master Wirtschaftsinformatik > Bereichswahlmodule

**Contact person**
- module responsibility
  - Claus Möbus
- authorized examiners
  - Die im Modul Lehrenden
- Module counseling
  - Die im Modul Lehrenden

**Prerequisites**

**Skills to be acquired in this module**

- Probabilistic Bayesian models are generated with special tools (e.g. BUGS, JAGS, STAN) or programming languages (CHURCH, FIGARO, etc.). If they mimic cognitive processes of humans (e.g. pilots, drivers) or animals they could be used as assistance systems in technical systems like cars or robots.

**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

<table>
<thead>
<tr>
<th>Module contents</th>
<th>Theories, methods, and examples of Bayesian models with practical applications</th>
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<tbody>
<tr>
<td>Recommended reading</td>
<td>Recent eBooks, eTutorials</td>
</tr>
<tr>
<td>Links</td>
<td><a href="http://www.uni-oldenburg.de/en/computingscience/lcs/probabilistic-programming/">http://www.uni-oldenburg.de/en/computingscience/lcs/probabilistic-programming/</a></td>
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**Examination**
- examination periods
- Type of examination
  - Presentation, reflective summary

**Final exam of module**
inf537 - Intelligent Systems

Module name: Intelligent Systems

Module code: inf537

ECTS credit points: 6.0 KP

Workload: 180 h

Used in degree programmes:
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule
- Master Wirtschaftsinformatik > Akzentsetzungsmodul Bereich Wirtschaftsinformatik

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

Prerequisites:

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.

Recommended reading:

Suggested reading:

- Ghallab/ Nau/Traverso: Automated Planning, Morgan Kaufman, 2004

Links

Languages of instruction: German, English

Duration (semesters): 1 semester
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inf650 - Transport Systems

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<td>Axel Hahn</td>
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<td>Die im Modul Lehrenden</td>
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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

Recommended reading
Suggested reading:
<table>
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<th><a href="http://wi-ol.de">http://wi-ol.de</a></th>
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| Total attendance time of module | 56 h |
**inf903 - Research Project I**

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| **Used in degree programmes** | - Master Engineering of Socio-Technical Systems > Systems Engineering  
- Master Wirtschaftsinformatik > Akzentsetzungsmodul Bereich Wirtschaftsinformatik |
| **Contact person** | module responsibility |
| | » Axel Hahn |
| | » Die im Modul Lehrenden |

**Prerequisites**

**Skills to be acquired in this module**

**Module contents**

**Recommended reading**

**Links**

**Languages of instruction**

**Duration (semesters)** | 1 semester |
| **Module frequency** | --- |
| **Module capacity** | unlimited |
| **Modullevel** | --- |
| **Modulart** | je nach Studiengang Pflicht oder Wahlpflicht |

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

**Vorkenntnisse / Previous knowledge**

**Examination**

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### Abschlussmodul

**mam - Master`s Thesis Module**

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