Basiskompetenzen/Grundlagen

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

<table>
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<td>Module code</td>
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<tr>
<td>Credit points</td>
<td>6.0 KP</td>
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<tr>
<td>Workload</td>
<td>180 h</td>
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<tr>
<td>Used in course of study</td>
<td>Master Engineering of Socio-Technical Systems &gt; Basiskompetenzen/Grundlagen</td>
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Contact person

Module responsibility

- Martin Georg Fränzle
- Andreas Hein

Authorized examiners

- Die im Modul Lehrenden

Entry requirements

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

Module contents

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

Reader's advisory

essential: Slides
recommended:
- Meyer, M.; Signalverarbeitung: Analog und digitale Signale, Systeme und Filter
- Grüning, D. C. v.; Digitale Signalverarbeitung; mit einer Einführung in die kontinuierlichen Signale und Systeme
- Tönnies, K.; Grundlagen der Bildverarbeitung; Pearson Studium 2005
- Lehmann, Th.; Oberschelp, W.; Pelinak, E.; Pepges, R.; Bildverarbeitung in der Medizin; Springer Verlag 1997

Links

Language of instruction: English
Duration (semesters): 1 Semester
Module frequency: Once a year
Module capacity: Unlimited
Reference text: This course is part of the base curriculum of the MSc programme "Engineering of Socio-Technical Systems". It provides students featuring a background in psychology with fundamental competences in computer science and related subjects. This course is not intended for students with a background in computer science.

Modullevel: BC (Basiscurriculum / Base curriculum)
Modulart: Pflicht o. Wahlpflicht / compulsory or optional
Lern-Lehrform / Type of program: V+Ü

Vorkenntnisse / Previous knowledge

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<th>Examination</th>
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<tbody>
<tr>
<td>Final exam of module</td>
<td>At the end of the lecture period</td>
<td>Hands-on exercises and written or oral exam</td>
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<th>Workload attendance</th>
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<tr>
<td>Lecture</td>
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<td>WiSe</td>
<td>28 h</td>
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<tr>
<td>Exercises</td>
<td>2.00</td>
<td>WiSe</td>
<td>28 h</td>
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Total time of attendance for the module: 56 h
The courses provide an introduction to the fundamental methods of mathematical formalisation and proof, as well as to the central concepts of graph theory, elementary number theory, and algebra. The selection of topics is based on their particular relevance to computer science and related disciplines.

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

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

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

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

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

The module consists of a lecture and an exercise part.

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

**Language of instruction**
English

**Duration (semesters)**
1 Semester

**Module frequency**
compulsory

**Module capacity**
unlimited

**Reference text**
This course is part of the base curriculum of the MSc program "Engineering of Socio-Technical Systems". It provides students featuring a background in psychology with fundamental competences in computer science and related subjects. This course is not intended for students with a background in computer science.

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

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

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

**Vorkenntnisse / Previous knowledge**

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**Workload attendance**

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<tr>
<td>Exercises</td>
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</table>

**Total time of attendance for the module**
56 h
inf962 - Fundamental Competences in Computing Science III: Algorithms and Computational Problem Solving

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

**Module code**: inf962

**Credit points**: 6.0 KP

**Workload**: 180 h

**Used in course of study**: Master Engineering of Socio-Technical Systems > Basiskompetenzen/Grundlagen

**Contact person**: Lehrende der Informatik, Authorized examiners: Die im Modul Lehrenden

**Entry requirements**: Knowledge of a programming language may be helpful, but is not required

**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 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.

**Language of instruction**: English

**Duration (semesters)**: 1 Semester

**Module frequency**: once a year

**Module capacity**: unlimited

**Reference text**: This course is part of the base curriculum of the MSc program "Engineering of Socio-Technical Systems". It provides students featuring a background in psychology with fundamental competences in computer science and related subjects. This course is not intended for students with a background in computer science.

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

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

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

**Vorkenntnisse / Previous knowledge**: Knowledge of a programming language may be helpful, but is not required.

**Examination**

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

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<td>Master Engineering of Socio-Technical Systems &gt; Basiskompetenzen/Grundlagen</td>
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**Contact person**

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

**Entry requirements**

**Skills to be acquired in this module**

The module aims to provide an overview of theories of cognitive processes.

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

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

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

**Competencies:**

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

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

**Professional competences:**

- Neuropsychological / neurophysiological knowledge

**Methodological competences:**

- interdisciplinary knowledge & thinking

**Social competences:**

- Written and oral presentation and discussion of scientific and technical results with others.

**Self-competences:**

- Reading, understanding, summarizing and critically evaluating scientific texts/literature

**Module contents**

**Part 1 neurocognition:**


**Part 2 neurophysiology:**


### Part 3 cognitive engineering:

- Paternò, F (2000). Model-Based Design and Evaluation of Interactive Applications
- Wickens & Hollands (2012). Engineering Psychology & Human Performance

### Reader’s advisory

<table>
<thead>
<tr>
<th>Links</th>
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<tbody>
<tr>
<td>Language of instruction</td>
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<td>Duration (semesters)</td>
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<td>Modulelevel</td>
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<td>Modulart</td>
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<td>Lern-/Lehrform / Type of program</td>
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### Vorkenntnisse / Previous knowledge

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<td>Written exam. A bonus system will be employed.</td>
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<tr>
<td>Seminar</td>
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### Total time of attendance for the module

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### Module Overview

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

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<td>Workload</td>
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<td>Used in course of study</td>
<td>Master Engineering of Socio-Technical Systems &gt; Basiskompetenzen/Grundlagen</td>
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**Contact person**

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

**Entry requirements**

**Skills to be acquired in this module**

The module aims to provide an overview of theories of (Neuro)Cognitive Psychology with potential for application, concepts for technology assessments and ethical principals and their applicability for the field of (Neuro)Cognitive Psychology. In addition to these learning aims, they will experience chances and limitations of technology assessments. Thus, it will cover core concepts of cognitive psychology, their neuronal basis, basic knowledge of neuroimaging and data analysis techniques. Special emphasis will be put on research aiming at complex real-world settings and translation of basic science 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:**

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

**Methodological competences:**

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

**Social competences:**

- The students should be able to argue on different point of views based on different.

**Self-competences:**

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

**Module contents**

The module consists of a lecture and an seminar part:

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

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

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

**Reader’s advisory**

**Links**

**Language of instruction**
- English

**Duration (semesters)**
- 1 Semester

**Module frequency**
- Once a year

**Module capacity**
- Unlimited

**Reference text**
The module will be offered in summer terms and should be completed within one semester. Both parts will run in parallel.

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

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

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

**Vorkenntnisse / Previous knowledge**

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<tr>
<td>Final exam of module</td>
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<td>Portfolio</td>
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**Course type**

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

Module label
Foundations of STS Eng.: Systems Engineering

Module code
inf965

Credit points
6.0 KP

Workload
180 h

Used in course of study
- Master Engineering of Socio-Technical Systems > Basiskompetenzen/Grundlagen

Contact person
Module responsibility
- Axel Hahn
- Martin Georg Fränzle

Authorized examiners
- Die im Modul Lehrenden

Entry requirements
Professional competences:
Designing and maintaining complex artefacts are a major challenge of engineering for decades. System Engineering is an approach to handle this complexity. By completing this module, the students are aware of the challenges of complexity. They know how systems engineering can address these while designing complex but reliable, dependable and safe products. A major 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 a modelling approach.
Exercises: Own design experiences by using engineering methods and tools.

Reader's advisory

Links

Language of instruction
English

Duration (semesters)
1 Semester

Module frequency
Once a year

Module capacity
unlimited

Modulart
BC (Basiscurriculum / Base curriculum)

Lern-/Lehrform / Type of program
V+Ü

Vorkenntnisse / Previous knowledge

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

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**Contact person**
- Antje Timmer
- Andreas Hein

**Authorized examiners**
- Die im Modul Lehrenden

**Entry requirements**

**Skills to be acquired in this module**

**Professional competences:**
The students learn:
- To plan, program and interpret statistical data evaluation via programming.

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

**Social competences:**
The students gain experience in interdisciplinary work.

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

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

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

**Reader’s advisory**

**Links**
- **Language of instruction**
  - English
- **Duration (semesters)**
  - 1 Semester
- **Module frequency**
  - Once a year
- **Module capacity**
  - unlimited
- **Modullevel**
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### inf970 - Fundamental Competences in Psychology I: Psychology

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<td>Credit points</td>
<td>6.0 KP</td>
</tr>
<tr>
<td>Workload</td>
<td>180 h</td>
</tr>
<tr>
<td>Used in course of study</td>
<td>• Master Engineering of Socio-Technical Systems &gt; Basiskompetenzen/Grundlagen</td>
</tr>
</tbody>
</table>

#### Contact person
- Module responsibility
  - Christoph Siegfried Herrmann
  - Die im Modul Lehrenden
- Authorized examiners
  - Die im Modul Lehrenden

#### Entry requirements
- **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:
- 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.

#### Reader's advisory

#### Links
- **Language of instruction**: English
- **Duration (semesters)**: 1 Semester
- **Module frequency**: once a year
- **Module capacity**: unlimited
- **Reference text**: This course is part of the base curriculum of the MSc program "Engineering of Socio-Technical Systems". It provides students featuring a background in computer science with fundamental competences in psychology and related subjects. This course is not intended for students with a background in psychology
- **Modullevel**: BC (Basiscurriculum / Base curriculum)
- **Modulart**: Pflicht o. Wahlpflicht / compulsory or optional
- **Lern-Lehrform / Type of program**: V+Ü

#### Vorkenntnisse / Previous knowledge

<table>
<thead>
<tr>
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<th>Type of examination</th>
</tr>
</thead>
<tbody>
<tr>
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<td>During the last lecture appointment</td>
<td>Written exam</td>
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<tr>
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<td></td>
<td>2.00</td>
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<td>Exercises</td>
<td></td>
<td>2.00</td>
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<td>28 h</td>
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**Total time of attendance for the module**

56 h
inf971 - Fundamental Competences in Psychology II: Introduction to Cognitive Neuroscience

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

Module code
inf971

Credit points
6.0 KP

Workload
180 h

Used in course of study
- Master Engineering of Socio-Technical Systems > Basiskompetenzen/Grundlagen

Contact person
Module responsibility
- Christiane Margarete Thiel

Authorized examiners
- Die im Modul Lehrenden

Entry requirements

Skills to be acquired in this module
- Introduction to basic concepts of neurobiological foundations of sensory, motor and cognitive functions
- Professional competences:
  - The students will be able to understand basic concepts of neurobiological foundations of cognition and present these to fellow students of different backgrounds:

  - Methodological competences:
    - The students will learn to present and discuss scientific findings

  - Social competences:
    - The students will learn to interact in a group

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

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

Reader's advisory

Links
Language of instruction
English

Duration (semesters)
1 Semester

Module frequency
once a year

Module capacity
unlimited

Reference text
Comments:
This course is part of the base curriculum of the MSc program "Engineering of Socio-Technical Systems". It provides students featuring a background in computer science with fundamental competences in psychology and related subjects. This course is not intended for students with a background in psychology.

This is part of a neurobiology module offered for biology students

Modullevel
BC (Basiscurriculum / Base curriculum)

Modulart
Pflicht o. Wahlpflicht / compulsory or optional

Lern-/Lehrform / Type of program
V+S

Vorkenntnisse / Previous knowledge

Examination
Time of examination
Type of examination

Final exam of module
March
Written exam

Course type
Comment
SWS
Frequency
Workload attendance

Lecture
2.00
WiSe
28 h

Seminar
2.00
WiSe
28 h

Total time of attendance for the module
56 h
inf972 - Fundamental Competences in Psychology III: Experiments and Studies

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

Module code: inf972

Credit points: 6.0 KP

Workload: 180 h

Used in course of study: Master Engineering of Socio-Technical Systems > Basiskompetenzen/Grundlagen

Contact person:
Module responsibility
- Susanne Boll-Westermann

Authorized examiners
- Die im Modul Lehrenden

Entry requirements

Skills to be acquired in this module

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

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

Module contents

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

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

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

Tools
- SoSci Survey for online survey
- Statistic Tools

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

Ethics
- Institutional Review Boards
- Informed Consent

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

Reader’s advisory

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

Links

<table>
<thead>
<tr>
<th>Language of instruction</th>
<th>German</th>
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Vorkenntnisse / Previous knowledge

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<td>practical work and oral exam</td>
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<td>Exercises</td>
<td>2.00</td>
<td>WiSe</td>
<td>28 h</td>
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Total time of attendance for the module 56 h
Human-Computer Interaction

inf100 - Human Computer Interaction

Module label: Human Computer Interaction
Module code: inf100
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodulle
- 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

Entry requirements:

Skills to be acquired in this module:

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

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

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

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

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

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

Language of instruction: German
Duration (semesters): 1 Semester
Module frequency: once a year
Module capacity: unlimited
Modullevel: AS (Akzentsetzung / Accentuation)
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<td>V+P</td>
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<tr>
<td>Vorkenntnisse / Previous knowledge</td>
<td>Basic programming skills</td>
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<tr>
<td>Examination</td>
<td>Time of examination</td>
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<tr>
<td>Final exam of module</td>
<td>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>
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<table>
<thead>
<tr>
<th>Course type</th>
<th>Comment</th>
<th>SWS</th>
<th>Frequency</th>
<th>Workload attendance</th>
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<td>SuSe</td>
<td>28 h</td>
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<tr>
<td>Practical</td>
<td>2.00</td>
<td></td>
<td>SuSe</td>
<td>28 h</td>
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Total time of attendance for the module 56 h
inf131 - Advanced Topics in Human Computer Interaction

Module label: Advanced Topics in Human Computer Interaction
Module code: inf131
Credit points: 6.0 KP
Workload: 180 h

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

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

Authorized examiners:
- Die im Modul Lehrenden

Entry requirements:
This course aims to provide a sample of some of the most recent and significant advances in this exciting area. Topics may include: situational awareness, designing for attention, ambient/peripheral interaction, computer support 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 artifact

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

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

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

Module contents:
HCI is a fast-growing field, where scientific research in this area crosses multiple disciplines. The body of theoretical and empirical knowledge that can inform the design of effective systems is rapidly developing, which underscores the importance of current research in the field.

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

**Structure of the Module:**

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

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

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

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

**Reader's advisory**

**Suggested reading:**


**Links**

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

**Examination**

<table>
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<th>Final exam of module</th>
<th>At the end of the lecture period</th>
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<tbody>
<tr>
<td>Project and oral exams</td>
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</table>

**Missing the exam**

If you cannot attend the exam with valid reasons (medical reason, exam schedule conflicts), you need to inform us before the exam, and submit a scanned copy of the evidence (medical certificate, course registration, boarding passes) within 5 days after the exam.

- If the reason for missing the exam is valid, you will do your first try of the exam for the parts that you missed on the same date as the second chance exam.
- If the reason is not valid, you will not get any score from that exam. If your overall score passed the course, you will not have a chance to take the exam again.

**Grading:**

Your grade will be calculated as follows:

<table>
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<tr>
<th>Scored Items</th>
<th>%</th>
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<tr>
<td>Final</td>
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<tr>
<td>Assignments A01-03</td>
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<tr>
<td>Mini HCI research project</td>
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**Course type**

<table>
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<th>SWS</th>
<th>Frequency</th>
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<tr>
<td>Lecture</td>
<td>2.00</td>
<td>SuSe or WiSe</td>
<td>28 h</td>
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<tr>
<td>Practical</td>
<td>2.00</td>
<td>SuSe or WiSe</td>
<td>28 h</td>
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**Total time of attendance for the module**

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

Module label: Special Topics in 'Media Informatics and Multimedia Systems' II
Module code: inf174
Credit points: 6.0 KP
Workload: 180 h

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

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

Module counseling:
- Die im Modul Lehrenden

Entry requirements

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

Professional competences
The students:

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

Methodological competences
The students:

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

Social competences
The students:

- Support team process by their abilities

Self-competences
The students:

- Pursue the overall and special computer science development critically
- Implement innovative professional activities effectively and independently

Module contents
According to the assigned course

Reader’s advisory
As announced in course

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: 2 courses out of V, S, Ü, P, PR
Vorkenntnisse / Previous knowledge
<table>
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<tr>
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<td>At the end of the lecture period</td>
<td>Portfolio or presentation or oral exam</td>
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<tr>
<td>SWS</td>
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<tr>
<td>Frequency</td>
<td>SuSe or WiSe</td>
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<td>Workload attendance</td>
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</table>
inf175 - Special Topics in 'Media Informatics and Multimedia Systems' II

Module label
Special Topics in 'Media Informatics and Multimedia Systems' II

Module code
inf175

Credit points
6.0 KP

Workload
180 h

Used in course of study
- Master Engineering of Socio-Technical Systems > Human-Computer Interaction
- Master Informatik > Mastermodule

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

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

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

Skills to be acquired in this module

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

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

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

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

Module contents
According to the assigned course

Reader's advisory
As announced in course

Links

Languages of instruction
German, English

Duration (semesters)
1 Semester

Module frequency
unregelmäßig

Module capacity
unlimited

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
<table>
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<th>Type of examination</th>
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<td>Exercises or presentation Semesterbegleitende or oral exam</td>
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<td>Course selection</td>
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<tr>
<td>SWS</td>
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<td>Frequency</td>
<td>WiSe</td>
<td></td>
</tr>
<tr>
<td>Workload attendance</td>
<td>28 h</td>
<td></td>
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</table>
inf301 - Machine-oriented Systems Engineering

Module label: Machine-oriented Systems Engineering
Module code: inf301
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- Master 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
- Die im Modul Lehrenden

Authorized examiners:
- Alfred Mikschl
- Die im Modul Lehrenden

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

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

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

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

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

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

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

Links:
Languages of instruction: German, English
Duration (semesters): 1 Semester
Module frequency: semi-annual
Module capacity: unlimited
Modulelevel: 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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<tr>
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<td>Portfolio (Design, development and implementation of embedded systems, colloquium)</td>
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Total time of attendance for the module 56 h
inf303 - Fuzzy Control and Artificial Neural Networks in Robotics and Automation

Module label
Fuzzy Control and Artificial Neural Networks in Robotics and Automation

Module code
inf303

Credit points
6.0 KP

Workload
180 h

Used in course of study
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodulle
- 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

Entry requirements

Skills to be acquired in this module

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

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

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

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

Objective of the module / skills:

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

Module contents

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

**Reader's advisory**

**Essential:**

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

**Recommended:**


**Secondary Literature:**

- Altrock, M. O. R.: Fuzzy Logic, R. Oldenbourg Verlag, 1993
- Kahlerl, J. und Hubert, F.: Fuzzy-Logik und Fuzzy-Control, Vieweg, 1993
- Klatzer, K.P.: Neuronale Netze, Carl Hanser, 1993
- Lawrence, J.: Neuronale Netze, Synthese 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.): 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

**Lern-Lehrform / Type of program**

V+Ü

**Vorkenntnisse / Previous knowledge**

Control engineering

**Examination**

Time of examination

At the end of the lecture period until the beginning of the next semester

Hands-on-exercises and oral Exam

**Final exam of module**

**Course type**

Lecture

3.00

SuSe

42 h

Exercises

1.00

SuSe

14 h
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inf305 - Medical Technology

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

Used in course of study:
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodulle
- 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

Entry requirements:

Skills to be acquired in this module:

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

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

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

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

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

Reader’s advisory:

essential:

recommended:
- Lecture slides

**secondary literature:**


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**Links**

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| Vorkenntnisse / Previous knowledge | - Signal and Image Processing
- Control Engineering |
| Examination              | Portfolio: Hands-on exercises, report, and written or oral exam |
| Time of examination      | At the end of the lecture periode |

| Final exam of module     | | |
|--------------------------|--------------------------|
| Lecture                  | Comment | SWS | Frequency | Workload attendance |
| 3.00                     | WiSe    | 42 h|
| Exercises                | 1.00     | WiSe| 14 h      |

**Total time of attendance for the module**
31 / 139
**inf307 - Robotics**

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**Used in course of study**
- 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

**Entry requirements**

**Skills to be acquired in this module**

**Professional competence**

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

**Methodological competence**

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

**Social competence**

The students:
- Solve robot systems problems in team work

**Self-competence**

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

**Module contents**

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

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

- Actuators

**Reader's advisory**

**essential:**
- lecture notes

**recommended:**

**secondary literature:**

**Links**

**Languages of instruction**
- German, English

**Duration (semesters)**
- 1 Semester

**Module frequency**
- once a year

**Module capacity**
- unlimited

**Module level**
- AS (Akkzentsetzung / Accentuation)

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

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

**Vorkenntnisse / Previous knowledge**

**Examination**

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

**Module label**  
Microrobotics II

**Module code**  
inf308

**Credit points**  
6.0 KP

**Workload**  
180 h

**Used in course of study**
- Master 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

**Entry requirements**

After having given an established introduction in the module “Microrobotics and Microsystem Technology” this lecture offers a further specialization 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.

**Skills to be acquired in this module**

**Professional competence**
The students:
- name and recognise the basic concepts of nanotechnology, in particular, micro- and nanorobotics approaches
- differentiate the development, control and application of micro- and nanorobotics systems
- implement and design application-specific micro- and nanorobotics systems

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

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

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

**Module contents**

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

**Reader’s advisory**

- Lecture notes (can be obtained in secretariat, A1-3-303)
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| **Total time of attendance for the module** | 56 h |
inf330 - Embedded Systems

Module label: Embedded Systems
Module code: inf330
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- 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
- Werner Damm
- Wolfgang Nebel
- Martin Georg Fränzle

Entry requirements:

Skills to be acquired in this module:
This module provides an introduction to the design of digital embedded systems

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

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

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

Self-competences:
The students:
- Acknowledge the limits of their ability to cope with pressure during the implementation process of systems
- Solve exercises self-responsibly

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

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

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

Reader's advisory:
Slides and
**Secondary literature:**

- Artikelserie zum MPEG-2-Standard 3/94 - 10/94 und das Tutorial "Digitale Bildcodierung" 1/92 - 1/93, beides in "Fernseh- und Kinotechnik" (BIS: Z et ZA 1536)

**Links**

- Language of instruction: English
- Duration (semesters): 1 Semester
- Module capacity: unlimited
- Reference text: This module is compulsory for students who are specialising in "Eingebettete Systeme und Mikrorobotik".
inf333 - Sensor Technology in the Automotive Domain

Module label: Sensor Technology in the Automotive Domain

Module code: inf333

Credit points: 6.0 KP

Workload: 180 h

Used in course of study:
- Master 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
- Frank Köster

Entry requirements:
This module introduces the principles of sensors and sensor-systems as well as data-fusion in the automotive domain.

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

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

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

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

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

Reader’s advisory:
Suggested reading:

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inf336 - Application Area Automotive

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**Used in course of study**
- 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
  - Frank Köster

**Entry requirements**
This module introduces the application area Automotive.

**Skills to be acquired in this module**

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

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

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

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

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

**Reader's advisory**
**Links**

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<td>2.00</td>
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**Total time of attendance for the module**: 56 h
inf522 - Information Processing in Bio-Medical Research

Module label: Information Processing in Bio-Medical Research
Module code: inf522
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- Master 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
- Rainer Röhrig

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

Skills to be acquired in this module:

**Professional competences:**
The students:

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

**Methodological competences:**
The students:

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

**Social competences:**
The students:

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

**Self-competences:**
The students:

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

Module contents:

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

<table>
<thead>
<tr>
<th>Reader's advisory</th>
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<tbody>
<tr>
<td>Languages of instruction</td>
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| Total time of attendance for the module | 56 h |
## inf523 - Medical Software Engineering

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<tr>
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<td>This Module provides the regulatory requirements of medical software. Focus is on software life cycle methods and approaches, the implementation of combined usability- and risk management processes as well as quality management.</td>
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<td>Professional competence</td>
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<tr>
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<td>Know and use obligatory medical software requirements</td>
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<td></td>
<td>Know methods and approaches to develop security-critical medical software and implement them by example</td>
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<td>Know at least one medical application area and its specific professional, organisational and regulatory requirements</td>
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<td>Methodological competence</td>
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<tr>
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<td>Are able to apply risk management methods of socio-technical systems</td>
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<td></td>
<td>Are able to extend their knowledge of new application areas. They are able to handle the obstacles of normative frameworks and software development.</td>
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<td>Social competence</td>
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<tr>
<td></td>
<td>Realise the importance of communication during the software development process between developer, customer and user of a successful and secure system. Feedback, request, respectful cooperation and empathy of other disciplines' working processes are of great importance.</td>
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<td>The students:</td>
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<td>Realise their responsibility as a computer scientist and reflect their impact on patients, medical employers and hospitals (corporates)</td>
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<td>Module contents</td>
<td>Content of the Module:</td>
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<td>This module provides medical software development processes. The module deals with normative software requirements with the focus on patient privacy and quality management. Contents are the declaration of conformity based on medical product classes and software security classes. The software security is focused on software quality, tests and verification, validation as well as quality and risk management. The software life cycle provides security related systems and software as well as software architecture and different process models.</td>
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**Total time of attendance for the module**

56 h
# inf532 - Introduction to Cognitive Engineering

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**Used in course of study**
- 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

**Entry requirements**

**Skills to be acquired in this module**

**Professional competences:**
The students:
- Understanding of state of the art methods, techniques and tools (MTTs) to describe, model and evaluate human performance in safety-critical systems.
- Basic understanding of cognitive 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 our lab to end up with concrete human performance predictions.

**Reader’s advisory**
Each lecture covers usually a specific chapter of one of the following books or articles:
- Model-Based Design and Evaluation of Interactive Applications (Fabio Paternò)
- Introduction to ACT-R (John R. Anderson, Christian Lebiere)
- Engineering Psychology and Human Performance (Chris Wickens, Justin Hollands)
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Application Area Automotive
Usability in Medicine |
| Module level | AC (Aufbaucurriculum / Composition) |
| Modular | Pflicht o. Wahlpflicht / compulsory or optional |
| Lern-Lehrform / Type of program | V+Ü |
| Vorkenntnisse / Previous knowledge | Helpful previous knowledge:
Fundamental Competences in Psychology I
Fundamental Competences in Psychology III
Applied Cognitive Psychology
Human Computer Interaction |

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Total time of attendance for the module: 56 h
### inf537 - Intelligent Systems

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<td></td>
<td>Jürgen Sauer</td>
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<td>Jürgen Sauer</td>
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<td>Professional competence</td>
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<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>• name the structure of agent-based systems</td>
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<td>• use problem-solving methods for complex problems</td>
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<td></td>
<td>• characterise the application area of process planning</td>
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<td>• evaluate the suitability of processes regarding to specific problems</td>
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<td>Methodological competence</td>
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<td>The students:</td>
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<td>• assign problem-solving methods to different problems</td>
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<td>Social competence</td>
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<td>The students:</td>
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<td></td>
<td>• implement selected methods in small teams</td>
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<td>Self-competence</td>
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<td>The students:</td>
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<td>• develop own solutions for given problems</td>
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<td>Module contents</td>
<td>A lot of application areas use &quot;intelligent&quot; 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:</td>
</tr>
<tr>
<td></td>
<td>• A brief introduction into AI</td>
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<td>• Agent systems and</td>
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<td></td>
<td>• Solution methods of AI like heuristics, meta-heuristics, soft computing methods.</td>
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<td>To apply and foster the contents of the lecture, an intelligent planning system is implemented in practical exercises.</td>
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<tr>
<td>Reader's advisory</td>
<td>Suggested reading:</td>
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<tr>
<td></td>
<td>• Sauer, J.: Intelligente Ablaufplanung in lokalen und verteilten Anwendungsszenarien, Teubner, 2004</td>
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<td></td>
<td>• Russell/Norvig: Künstliche Intelligenz, 3rd edition, Pearson, 2012</td>
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<td>• Ghallab/ Nau/Traverso: Automated Planning, Morgan Kaufman, 2004</td>
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### Duration (semesters)
1 Semester

### Module frequency
once a year

### Module capacity
unlimited

### Modul level
AS (Akzentsetzung / Accentuation)

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

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

### Vorkenntnisse / Previous knowledge
Produktionsorientierte Wirtschaftsinformatik

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

Module label: Transport Systems

Module code: inf650

Credit points: 6.0 KP

Workload: 180 h

Used in course of study:
- Master 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
- Die im Modul Lehrenden

Authorized examiners:
- Axel Hahn
- Die im Modul Lehrenden

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

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

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

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

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

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

Reader’s advisory:
Suggested reading:

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### Examination

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### Total time of attendance for the module

56 h
**Embedded Brain Computer Interaction**

**inf100 - Human Computer Interaction**

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<td>Master Informatik &gt; Mastermodule</td>
<td></td>
</tr>
<tr>
<td>Master Wirtschaftsinformatik &gt; Bereichswahlmodule</td>
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</tr>
</tbody>
</table>

**Contact person**

Module responsibility

- Susanne Boll-Westermann
- Die im Modul Lehrenden

Authorized examiners

- Susanne Boll-Westermann
- Die im Modul Lehrenden

**Entry requirements**

**Skills to be acquired in this module**

**Professional competence**

The students:

- Name the human-computer interaction core principles
- Characterise the basic elements of the human-centered design of interactive systems

**Methodological competence**

The students:

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

**Social competence**

The students:

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

**Module contents**

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

**Reader's advisory**

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

**Links**

medien.informatik.uni-oldenburg.de/lehre

**Language of instruction**

German

**Duration (semesters)**

1 Semester

**Module frequency**

once a year

**Module capacity**

unlimited

**Modullevel**

AS (Akzentsetzung / Accentuation)
### Examination

<table>
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<tr>
<th>Examination</th>
<th>Time of examination</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>
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<th>Comment</th>
<th>SWS</th>
<th>Frequency</th>
<th>Workload attendance</th>
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<tr>
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<tr>
<td>Practical</td>
<td>2.00</td>
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</table>

### Total time of attendance for the module

56 h
inf300 - Hybrid Systems

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

Used in course of study
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodul
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Informatik > Mastermodule

Entry requirements

Skills to be acquired in this module

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

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

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

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

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

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

Reader's advisory
- Luca P Carloni, Roberto Passerone, Allesandro Pinto & Alberto L Sangiovanni-Vincentelli: Languages
- Daniel Liberzon: Switching in Systems and Control, Birkhauser, 2003

<table>
<thead>
<tr>
<th>Links</th>
<th>English, German</th>
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<td>Languages of instruction</td>
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<td>Duration (semesters)</td>
<td>1 Semester</td>
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<td>Module capacity</td>
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<td>Module level</td>
<td>AS (Akzentsetzung / Accentuation)</td>
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<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>
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<tr>
<td>Semester project including written work and final presentation</td>
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<th>Frequency</th>
<th>Workload attendance</th>
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<tr>
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<td>1.00</td>
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<td>14 h</td>
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</table>

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

Module label  Machine-oriented Systems Engineering
Module code    inf301
Credit points  6.0 KP
Workload       180 h

Used in course of study
- 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
  - Die im Modul Lehrenden

Authorized examiners
- Alfred Mikschl
- Die im Modul Lehrenden

Entry requirements

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

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

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

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

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

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

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

Links
Languages of instruction  German, English
Duration (semesters)    1 Semester
Module frequency        semi-anual
Module capacity         unlimited
Modulelevel             AS (Akzentsetzung / Accentuation)
Modulart               Pflicht o. Wahlpflicht / compulsory or optional
Lern-Lehrtform / 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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<tr>
<td>Final exam of module</td>
<td>At the end of the lecture period</td>
<td>Portfolio (Design, development and implementation of embedded systems, colloquium)</td>
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<table>
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<td>Practical</td>
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<td>2.00</td>
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**Total time of attendance for the module**

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

Module label
Fuzzy Control and Artificial Neural Networks in Robotics and Automation

Module code
inf303

Credit points
6.0 KP

Workload
180 h

Used in course of study
- Master Eingebettete Systeme und Mikrorobotik > 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
- Sergej Fatikow
- Die im Modul Lehrenden

Authorized examiners
- Sergej Fatikow
- Die im Modul Lehrenden

Entry requirements

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

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

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

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

Objective of the module / skills:

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

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

Reader's advisory

**Essential:**

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

**Recommended:**


**Secondary Literature:**

- Altrock, M. O. R.: Fuzzy Logic, R. Oldenbourg Verlag, 1993
- Kahlert, J. und Hubert, F.: Fuzzy-Logik und Fuzzy-Control, Vieweg, 1993
- Kretzer, 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
- Schulze, U.: Einführung in Fuzzy-Logik, Franzis-Verlag, München, 1993
- 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

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

**Vorkenntnisse / Previous knowledge**
Control engineering

**Examination**
Time of examination
Type of examination

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

**Course type**
Comment
SWS
Frequency
Workload attendance

<table>
<thead>
<tr>
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### inf305 - Medical Technology

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<tr>
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<tr>
<td>Module code</td>
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<tr>
<td>Credit points</td>
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<tr>
<td>Workload</td>
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</table>
| Used in course of study | - Master Eingebettete Systeme und Mikrorobotik > 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                                          |
| Entry requirements | Professional competence                                |
| Skills to be acquired in this module | 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: |
| Social competence  | - Recognise the interdisciplinary challenges and accordingly exchange information with other disciplines |
| Self-competence    | The students:                                          |
|                    | - Present solutions for specific questions              |
| Module contents    | Medical areas and areas of application                  |
|                    | Basic requirements for medical systems (hygiene, MPG, technical security, materials) |
|                    | Medical systems:                                       |
|                    | Functional diagnostics (ECG, EMG, EEG)                  |
|                    | Imaging systems (CT, MRI, ultrasound, PET, SPECT) - Therapy equipment (Laser, RF, Microtherapy) |
|                    | Signal processing / monitoring (cardiovascular, hemodynamic, respiratory, metabolic, cerebral) |
|                    | Medical Informatics (HIS, DICOM, Telemedicine, VR, image processing) |
| Reader's advisory  | essential:                                             |
|                    | - Lecture slides                                        |
|                    | recommended:                                           |
|                    | - [61 / 139](#)                                         |
• Dugas, M.; Schmidt, K.: Medizinische Informatik und Bioinformatik. Springer Verlag, 2003

secondary literature:


<table>
<thead>
<tr>
<th>Links</th>
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<tbody>
<tr>
<td>Languages of instruction</td>
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<td>Lern-Lehrform / Type of program</td>
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<td>Vorkenntnisse / Previous knowledge</td>
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<td>Portfolio: Hands-on exercises, report, and written or oral exam</td>
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Total time of attendance for the module 56 h
inf307 - Robotics

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

Used in course of study
- Master 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

Entry requirements

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

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

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

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

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

**Reader's advisory**

| essential: |
| lecture nodes |

**recommended:**


**secondary literature:**


**Links**

- Languages of instruction: German, English
- Duration (semesters): 1 Semester
- Module frequency: once a year
- Module capacity: unlimited
- Module level: AS (Akzentsetzung / Accentuation)
- Module type: Pflicht o. Wahlpflicht / compulsory or optional
- Learning/Teaching form: V+Ü

**Vorkenntnisse / Previous knowledge**

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<tbody>
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<td>Portfolio: Hands-on exercises, report, and written or oral exam</td>
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**Course type**

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<tr>
<td>Exercises</td>
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<td>SuSe</td>
<td>14 h</td>
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**Total time of attendance for the module**

56 h
# inf308 - Microrobotics II

<table>
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<tr>
<th>Module label</th>
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<tbody>
<tr>
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<td>Credit points</td>
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<td>Workload</td>
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</table>
| Used in course of study | • Master Eingebettete Systeme und Mikrorobotik > 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:                                |
|                       | • Sergej Fatikow                                     |
|                       | • Die im Modul Lehrenden                             |
| Authorized examiners  | • Sergej Fatikow                                     |
|                       | • Die im Modul Lehrenden                             |
| Entry requirements    | Skills to be acquired in this module:                |
|                       | After having given an established introduction in the module "Microrobotics and Microsystem Technology" this lecture offers a further specialisation in microrobotics. Within the course, all relevant areas (among others the research topics of the division "Microrobotics and Control Engineering (AMiR)") will be presented and analysed. The student will be provided with an insight into current research projects of AMiR and of other research institutes of microrobotics worldwide; here mainly the requirements of industry to microrobots will be discussed. The lecture will be enhanced by practical courses in the research laboratories of AMiR. |
| Professional competence | The students:                                      |
|                       | • name and recognise the basic concepts of nanotechnology, in particular, micro- and nanorobotics approaches  
                       | • differentiate the development, control and application of micro- and nanorobotics systems  
                       | • implement and design application-specific micro- and nanorobotics systems  |
| Methodological competence | The students:                                    |
|                       | • transfer their control engineering and image processing abilities on interdisciplinary problems  
                       | • transfer their hands-on experience to develop controls and applications of microrobotic systems on new tasks  |
| Social competence     | The students:                                        |
|                       | • work in a team                                     |
| Self-competence       | The students:                                        |
|                       | • reflect their problem-solving behaviour and use hands-on experience to develop, control and application of microrobotics  |
| Module contents       | Smart and versatile microrobots; microactuators (piezo-, ferrofluid- and SMA-actuators) for microrobots; real-time image processing in the micro world (SEM, optical microscopy); micro force sensors and tactile sensors for microrobots; microrobot control systems, e.g. neural networks and fuzzy logic; haptic interface for the control of microrobots; neural speech interface for the control of microrobots; robot-based micro- and nanohandling (SEM, optical microscopy); applications: microassembly, nano-testing, cell handling; Micro Air Vehicles (MAVs); multi-robot systems: team behavior, communication, control issues  |
| Reader's advisory     | • Lecture notes (can be obtained in secretariate, A1-3-303)  
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**Total time of attendance for the module**: 56 h
inf311 - Low Energy System Design

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

Used in course of study:
- Master 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
- Die im Modul Lehrenden

Authorized examiners:
- Die im Modul Lehrenden
- Wolfgang Nebel

Entry requirements:

Skills to be acquired in this module:
This module introduces the estimation of power dissipation and optimisation.

Professional competence
The students:

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

Methodological competence
The students:

- Model systems with a hardware description language
- Analyze and model hardware components
- Perform multi-dimensional optimization of systems

Social competence
The students:

- Implement solutions of given problems in teams
- Discuss their outcomes appropriately

Self-competence
The students:

- Acknowledge the limits of their ability to cope with pressure during the modeling process of systems

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

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

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

This module introduces the estimation of power dissipation and optimisation.

Reader's advisory:

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

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

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<td>Workload</td>
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| Used in course of study | • Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction  
                         | • Master Informatik > Mastermodule       |
| Contact person        | Module responsibility                     |
|                       | • Frank Köster                           |
|                       | • Die im Modul Lehrenden                  |
| Authorized examiners  |                                         |
|                       | • Frank Köster                           |
|                       | • Die im Modul Lehrenden                  |
| Entry requirements    | This module introduces the principles of automated driving. |
| Skills to be acquired in this module | The students:                             |
|                       | **Professional competences:**          |
|                       | The students:                           |
|                       | • Discuss different levels of automated driving (eg. SAE-Level) and the differences   |
|                       | • Discuss different levels of connected driving and the differences                    |
|                       | • Discuss core-domains of automated vehicles                                        |
|                       | • Discuss important technological pillars in the areas sense, plan, and act           |
|                       | • Discuss transition between different levels of automation                           |
|                       | • Discuss the impact of connected vehicle functions on automated driving              |
|                       | • Discuss the impact of automated vehicle functions on connected driving              |
|                       | • Characterise the impact of automated and connected driving on road traffic          |
|                       | • Characterise the interaction of humans and automated and connected vehicles         |
|                       | • Design an abstract procedure for the change of different levels of automation       |
|                       | • Design a rough vehicle architecture for automated and connected driving              |
|                       | **Methodological competences:**         |
|                       | The students:                           |
|                       | • Analyze complex automated and connected vehicles (-> domains)                       |
|                       | • Analyze core-functions of automated and connected vehicles (-> functions)           |
|                       | **Social competences:**                 |
|                       | The students:                           |
|                       | • Work in teams                         |
|                       | • Discuss their outcomes appropriately  |
|                       | **Self-competences:**                   |
|                       | The students:                           |
|                       | • Acknowledge the limits of their ability to cope with pressure during the analysis of complex (automated and connected) socio-technical systems |
| Module contents       | • levels of automated driving (eg. SAE-Level)                                        |
|                       | • levels of connected driving            |
|                       | • core-domains of automated vehicles     |
|                       | • sense, plan, and act in the context of automated and connected vehicles             |
|                       | • transition between different levels of automation                                 |
|                       | • selected connected vehicle functions   |
|                       | • selected automated vehicle functions   |
|                       | • human factors and socio-technical systems                                       |
|                       | • vehicle architectures                  |
| Reader's advisory     | Suggested reading:                      |

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

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

Used in course of study
- Master 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
- Andreas Hein

Entry requirements

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

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

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

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

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

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

Links

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

Vorkenntnisse / Previous knowledge

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<td></td>
<td>2.00</td>
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**Total time of attendance for the module**  56 h
inf333 - Sensor Technology in the Automotive Domain

Module label: Sensor Technology in the Automotive Domain

Module code: inf333

Credit points: 6.0 KP

Workload: 180 h

Used in course of study:
- Master 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
- Authorized examiners: Frank Köster

Entry requirements:

Skills to be acquired in this module:

- This module introduces the principles of sensors and sensor-systems as well as data-fusion in the automotive domain.

Professional competences:
The students:

- Discuss different levels/diverse levels sensor-technologies
- Discuss sensor-data fusion (multi-level fusion)
- Discuss Kalman-Filter
- Discuss in-vehicle data-processing
- Discuss 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

Reader's advisory:

Suggested reading:


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<td>2.00</td>
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| Total time of attendance for the module | 56 h |
inf334 - System Level Design

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

Used in course of study:
- Master 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
- Kim Grüttner

Entry requirements:
Skills to be acquired in this module:

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

Methodological competences:
The students:
- Knowledge of refinement and transformation techniques for transferring an initial specification into a real implementation
- Knowledge of the phases of a system-level design flow
- Knowledge of current design methods and tools in system level design
- Knowledge 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
text is presented that is already widely used in industry and research for the design and verification of
hardware/software systems and supports several abstraction levels from clock cycle accurate hardware
description, over transaction level models to process based functional specifications.

Reader's advisory

Suggested reading:

Main textbooks:
- D. Gajski, S. Abdi, A. Gerstlauer, G. Schirner, Embedded System Design: Modeling, Synthesis,
  Verification, Springer, 2009 ("orange book")
- D. C. Black, J. Donovan, B. Bunton, A. Keist, SystemC: From The Ground Up, Second Edition,
  Springer 2010 ("red book")

Optional books:
  & Sons, 2001 ("blue book"). Background about embedded systems in general
  2001 ("yellow book"). Practical, example-driven introduction using SpecC

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

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

Lecture
Exercises

Time of examination

at the end of the lecture period

Type of examination

hands-on exercises and oral exam

SWS

Workload attendance

2.00
2.00
28 h
28 h
56 h

Frequency

SuSe
SuSe

28 h

76 / 139
Inf335 - Strategy Synthesis

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

Used in course of study:
- 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
- Werner Damm

Entry requirements:

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.

Reader's advisory:
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>V+Ü</td>
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<td>Vorkenntnisse / Previous knowledge</td>
<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 modeling and analysis of reactive systems.</td>
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Examination

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Total time of attendance for the module 56 h
### inf336 - Application Area Automotive

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**Used in course of study**
- 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
  - Frank Köster

**Entry requirements**
This module introduces the application area Automotive.

**Skills to be acquired in this module**

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

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

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

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

**Module contents**

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

**Reader's advisory**

Springer.

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<td>Module capacity</td>
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<td>Modulelevel</td>
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<td>Lern-/Lehrform / Type of program</td>
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| Total time of attendance for the module | 56 h   |
inf338 - Design of Autonomous Systems

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<td></td>
<td>Master Informatik &gt; Mastermodule</td>
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<tr>
<td>Contact person</td>
<td>Module responsibility</td>
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<td></td>
<td>• Martin Georg Fränzle</td>
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<td>• Die im Modul Lehrenden</td>
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<td>• Martin Georg Fränzle</td>
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<tr>
<td>Entry requirements</td>
<td>Skills to be acquired in this module</td>
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<tr>
<td></td>
<td>Professional competences:</td>
</tr>
<tr>
<td></td>
<td>The students are enabled to analyze and build autonomous systems.</td>
</tr>
<tr>
<td></td>
<td>Methodological competences:</td>
</tr>
<tr>
<td></td>
<td>The students know examples of existing autonomous systems,</td>
</tr>
<tr>
<td></td>
<td>understand the elements involved in their architectural design</td>
</tr>
<tr>
<td></td>
<td>and the rationale behind decomposing the problem into obligations</td>
</tr>
<tr>
<td></td>
<td>for the respective system components. The module furthermore</td>
</tr>
<tr>
<td></td>
<td>enables the students to analyze existing architectures for</td>
</tr>
<tr>
<td></td>
<td>autonomous systems with respect to their performance and safety.</td>
</tr>
<tr>
<td></td>
<td>The students learn how to decompose a problem of designing an</td>
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<tr>
<td></td>
<td>autonomous system into an architecture, are able to derive design</td>
</tr>
<tr>
<td></td>
<td>obligations for its components, and can structure a pertinent</td>
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<tr>
<td></td>
<td>safety case. They understand the software and hardware components</td>
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<tr>
<td></td>
<td>necessary for achieving system autonomy and are able to design</td>
</tr>
<tr>
<td></td>
<td>or instantiate these.</td>
</tr>
<tr>
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<td>Social competences:</td>
</tr>
<tr>
<td></td>
<td>The students acquire hands-on experience in designing components</td>
</tr>
<tr>
<td></td>
<td>for autonomous systems in small teams and present the</td>
</tr>
<tr>
<td></td>
<td>underlying theory, their particular design decisions, and their</td>
</tr>
<tr>
<td></td>
<td>personal evaluation to fellow students.</td>
</tr>
<tr>
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<td>Self-competences:</td>
</tr>
<tr>
<td></td>
<td>The students can judge adequacy of their methodological skills</td>
</tr>
<tr>
<td></td>
<td>for designing particular autonomous solutions. They are able to</td>
</tr>
<tr>
<td></td>
<td>assess the safety impact of such a solution and are therefore</td>
</tr>
<tr>
<td></td>
<td>able to develop a personal ethical stance towards its</td>
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<td>realization.</td>
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<td>Final exam of module Second half of semester Presentation</td>
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### inf456 - Real-Time Systems

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**Used in course of study**
- 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, Ernst-Rüdiger Olderog

**Entry requirements**

**Skills to be acquired in this module**

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

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

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

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

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

Different specification methods have been developed to describe such timing conditions.

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

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

**Reader's advisory**


**Recommended:**


**Links**

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<td>Exercises and written or oral exam</td>
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**Total time of attendance for the module**

56 h
inf460 - Security

Module label: Security
Module code: inf460
Credit points: 6.0 KP
Workload: 180 h
Used in course of study:
- 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
 Authorized examiners:
- Die im Modul Lehrenden
- Sibylle Fröschle

Entry requirements:

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

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

Methodological competences:
The students:
- carry out a threat and risk assessment
- formulate security requirements for a given system
- identify and apply standard security solutions to meet them

(These are examples, the exact skills depend on the focus chosen by the student.)

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

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

Module contents:
This module provides a broad and comprehensive knowledge in computer security. The topics cover threat analysis and attack trees, essential cryptographic tools, user authentication, access control, malware, intrusion detection and prevention, denial-of-service attacks and defences, software security and trusted systems, and network security.

Students without prior knowledge in computer security focus on basic principles such as listed above. Students with prior knowledge in computer security can deepen their knowledge by studying real-world examples such as the SSL/TLS protocol. Typically, they will illustrate their topic by discussing a security incident reported in the public domain security news.

Reader's advisory:
### Links

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

<table>
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85 / 139
inf522 - Information Processing in Bio-Medical Research

**Module label**  
Information Processing in Bio-Medical Research

**Module code**  
inf522

**Credit points**  
6.0 KP

**Workload**  
180 h

**Used in course of study**
- Master 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
  - Rainer Röhrig

**Entry requirements**

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

**Skills to be acquired in this module**

**Professional competences:**
The students:

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

**Methodological competences:**
The students:

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

**Social competences:**
The students:

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

**Self-competences:**
The students:

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

**Module contents**

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

Reader's advisory

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

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

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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  
▪ Rainer Röhrig                                                                 |
| Entry requirements   | 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.                                                                 |
| 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.  
Reader’s advisory | Links                                                                                         |
<p>| Languages of instruction | German, English                                                                 |
| Duration (semesters) | 1 Semester                                                                                     |
| Module frequency     | once a year                                                                                     |</p>
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Total time of attendance for the module 56 h
inf536 - Computational Intelligence II

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<td>Oliver Kramer</td>
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<td>Die im Modul Lehrenden</td>
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<td>Oliver Kramer</td>
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</tbody>
</table>

**Entry requirements**

**Skills to be acquired in this module**

**Professional competence**

The students:

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

**Methodological competence**

The students:

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

**Social competence**

The students:

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

**Self-competence**

The students:

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

**Module contents**

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

**Overview of Content:**

- Foundations of learning and classification
- Nearest neighbouring methods
- Model selection and parameter tuning
- Regression
- Support vector and kernel methods
- Clustering
- Dimensionality reduction

**Reader's advisory**

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<td>Exercises</td>
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**Total time of attendance for the module** 56 h
inf537 - Intelligent Systems

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

Used in course of study
- Master 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
- Die im Modul Lehrenden

Authorized examiners
- Jürgen Sauer
- Die im Modul Lehrenden

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

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

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

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

Module contents
A lot of application areas use “intelligent” problem-solving methods. These are the main focus of this lecture. They will be illustrated by examples in order to enhance the students’ problem-solving abilities. These include:

- A brief introduction into AI
- Agent systems and
- Solution methods of AI like heuristics, meta-heuristics, soft computing methods.

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

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

Links
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**  
Produktionsorientierte Wirtschaftsinformatik

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**Total time of attendance for the module**  
56 h
**Module label**
Transport Systems

**Module code**
inf650

**Credit points**
6.0 KP

**Workload**
180 h

**Used in course of study**
- 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
- Die im Modul Lehrenden

Authorized examiners
- Axel Hahn
- Die im Modul Lehrenden

**Entry requirements**

**Skills to be acquired in this module**

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

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

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

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

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

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

**Reader’s advisory**
Suggested reading:

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<th><a href="http://wi-ol.de">http://wi-ol.de</a></th>
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| Total time of attendance for the module | 56 h |
inf973 - Psychological practicum fNIRS, EEG

Module label: Psychological practicum fNIRS, EEG
Module code: inf973
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction

Contact person:
Module responsibility:
- Jochem Rieger
- Die im Modul Lehrenden

Authorized examiners:
- Jochem Rieger
- Die im Modul Lehrenden

Entry requirements:

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.

Reader's advisory:

Links:
- Language of instruction: English
- Duration (semesters): 1 Semester
- Module frequency: Once a year
- Module capacity: 6
- Module level: AS (Akzentsetzung / Accentuation)
- Modulart: Pflicht / Mandatory
- Lern-/Lehrform / Type of program: P

Vorkenntnisse / Previous knowledge:

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

Course type: Practical
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# inf974 - Human Computer Interaction and Brain Computer Interfacing

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## Contact person
- Module responsibility
  - Jochem Rieger
  - Andreas Lüdtke
- Authorized examiners
  - Die im Modul Lehrenden

## Entry requirements

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

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

### Social competences:

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

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

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

## Reader's advisory

## Links
- **Language of instruction**: English
- **Duration (semesters)**: 2 Semester
- **Module frequency**: Once a year
- **Module capacity**: unlimited
- **Reference text**: 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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**Total time of attendance for the module** 56 h
Systems Engineering

inf301 - Machine-oriented Systems Engineering

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Used in course of study
- 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
- Alfred Mikschl
- Die im Modul Lehrenden

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

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

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

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

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

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

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

Links
Languages of instruction
German, English

Duration (semesters)
1 Semester

Module frequency
semi-annual

Module capacity
unlimited

Module level
AS (Akzentsetzung / Accentuation)

Modulart
Pflicht o. Wahlpflicht / compulsory or optional
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inf303 - Fuzzy Control and Artificial Neural Networks in Robotics and Automation

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**Used in course of study**
- 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

**Entry requirements**

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

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

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

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

**Objective of the module / skills:**

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

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

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

Recommended:

Secondary Literature:
- Altrock, M. O. R.: Fuzzy Logic, R. Oldenbourg Verlag, 1993
- Kahlert, J. und Hubert, F.: Fuzzy-Logik und Fuzzy-Control, Vieweg, 1993
- Klatzer, 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
- rd Li, X.: Neural Networks for Identification, Prediction and Control, Springer, 1997
- Schulte, U.: Einführung in Fuzzy-Logik, Franzis-Verlag, München, 1993
- 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
Lern-Lehrform / Type of program: V+Ü
Vorkenntnisse / Previous knowledge: Control engineering

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

Final exam of module
Course type Comment SWS Frequency Workload attendance
Lecture 3.00 SuSe 42 h
Exercises 1.00 SuSe 14 h

103 / 139
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inf305 - Medical Technology

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**Used in course of study**

- 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

**Entry requirements**

**Skills to be acquired in this module**

**Professional competence**

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

**Methodological competence**

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

**Social competence**

- The students:
  - Present solutions for specific questions

**Self-competence**

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

**Module contents**

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

**Reader's advisory**

**essential:**

- Lecture slides

**recommended:**

secondary literature:


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

Module label
Robotics

Module code
inf307

Credit points
6.0 KP

Workload
180 h

Used in course of study
- Master Eingebettete Systeme und Mikrorobotik > 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
- Die im Modul Lehrenden

Authorized examiners
- Die im Modul Lehrenden
- Andreas Hein

Entry requirements

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

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

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

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

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

Reader's advisory

**essential:**
lecture nodes

**recommended:**

**secondary literature:**

Links

Languages of instruction
German, English

Duration (semesters)
1 Semester

Module frequency
once a year

Module capacity
unlimited

Module level
AS (Akzentsetzung / Accentuation)

Modulart
Pflicht o. Wahlpflicht / compulsory or optional

Lern-/Lehrform / Type of program
V+Ü

Vorkenntnisse / Previous knowledge

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

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

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

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

Used in course of study
- Master 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

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

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

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

Social competence
The students:
- work in a team

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

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

Reader’s advisory
- Lecture notes (can be obtained in secretariate, A1-3-303)
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inf311 - Low Energy System Design

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**Used in course of study**
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodul
- Master Engineering of Socio-Technical Systems > Embedded Brain Computer Interaction
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

**Contact person**
- Wolfgang Nebel
- Die im Modul Lehrenden

**Entry requirements**

**Skills to be acquired in this module**
- This module introduces the estimation of power dissipation and optimisation.

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

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

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

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

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

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

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

This module introduces the estimation of power dissipation and optimisation.

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

Links

Languages of instruction German, English
Duration (semesters) 1 Semester
Module frequency jährlich
Module capacity unlimited
Module level AS (Akzentsetzung / Accentuation)
Module type Pflicht o. Wahlpflicht / compulsory or optional
Lern-Lehrform / Type of program V+Ü

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
Time of examination
Type of examination

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

Total time of attendance for the module 56 h

112 / 139
inf333 - Sensor Technology in the Automotive Domain

Module label: Sensor Technology in the Automotive Domain

Module code: inf333

Credit points: 6.0 KP

Workload: 180 h

Used in course of study:
- Master 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
- Frank Köster

Entry requirements:

Skills to be acquired in this module:

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

Reader's advisory

Suggested reading:

Links

Language of instruction English
Duration (semesters) 1 Semester
Module frequency once a year
Module capacity 100
Module level AS (Akzentsetzung / Accentuation)
Module type Pflicht o. Wahlpflicht / compulsory or optional
Lern-LEhrform / Type of program V+Ü

Vorkenntnisse / Previous knowledge

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<td>At the end of the lecture period</td>
<td>Practikal Work and oral exam</td>
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</table>

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

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

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

Used in course of study:
- Master 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
- Kim Grüttner

Entry requirements:

Skills to be acquired in this module

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

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

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

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

Module contents:
The ever-increasing integration densities of integrated circuits enable the implementation of increasingly powerful and complex systems. This can be on the one hand the integration of several sub-components on the same chip (system-on-chip) or on the other hand the implementation of more powerful algorithms. However, traditional design techniques are hardly able to cope with the increasing complexity of today’s embedded systems. Therefore, in research and practice efforts through new methods and tools, there is a significant increase in productivity in the design process, thus closing the so-called “design productivity gap”. This is achieved, for example, by a stronger abstraction, in which the behavior of components is described only at the algorithmic level and is automatically translated into hardware or software implementations by high-level synthesis techniques. The final system implementation is achieved by means of a structured refinement and exploration processes. Throughout this refinement flow, system properties (for example, timing, energy consumption, chip area and costs) are estimated on each abstraction level and guide the designer in the iterative decision process. By means of techniques such as virtual prototyping, entire systems can be simulated and verified on each refinement layer, even without the availability of a full implementation for all system components.

This module builds on the modules Embedded Systems I and II, deepens the knowledge acquired there for the
design of hardware/software systems and expands them with current methods and tools. With SystemC, a language is presented that is already widely used in industry and research for the design and verification of hardware/software systems and supports several abstraction levels from clock cycle accurate hardware description, over transaction level models to process based functional specifications.

Reader’s advisory

Suggested reading:

Main textbooks:


Optional books:


Additional reading material posted on Stud.IP

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

Language of instruction
English

Duration (semesters)
1 Semester

Module frequency
once a year

Module capacity
unlimited

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

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

Total time of attendance for the module
56 h
inf336 - Application Area Automotive

Module label: Application Area Automotive

Module code: inf336

Credit points: 6.0 KP

Workload: 180 h

Used in course of study:
- 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
- Frank Köster

Entry requirements:

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

Reader's advisory:

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### Vorkenntnisse / Previous knowledge

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### Course type

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<td>SuSe</td>
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### Total time of attendance for the module

| 56 h |
**Inf454 - Communicating and Mobile Systems**

**Module label**  
Communicating and Mobile Systems

**Module code**  
inf454

**Credit points**  
6.0 KP

**Workload**  
180 h

**Used in course of study**
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodule
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule

**Contact person**

**Module responsibility**  
Ernst-Rüdiger Olderog

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

**Entry requirements**

**Skills to be acquired in this module**

**Professional competence**

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

**Methodological competence**

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

**Social competence**

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

**Self-competence**

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

**Module contents**

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

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

**Topics:**

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

Reader's advisory


Links

Languages of instruction
German, English

Duration (semesters)
1 Semester

Module frequency
irregular

Module capacity
unlimited

Modulelevel
AS (Akzentsetzung / Accentuation)

Modularart
Pflicht o. Wahlpflicht / compulsory or optional

Lern-/Lehrform / Type of program
V+Ü

Vorkenntnisse / Previous knowledge
Theoretical Computer Science II

Examination
Time of examination
written exam or oral exam

Final exam of module
At the end of the lecture period

Course type
Comment
SWS
Frequency
Workload attendance

Lecture
3.00
SuSe
42 h

Exercises
1.00
SuSe
14 h

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

Module label
Real-Time Systems

Module code
inf456

Credit points
6.0 KP

Workload
180 h

Used in course of study
- Master 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
- Ernst-Rüdiger Olderog

Entry requirements

Skills to be acquired in this module

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

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

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

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

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

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

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

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

Reader's advisory


recommended:


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<td>1 Semester</td>
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<tr>
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<td>At the end of the lecture period</td>
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</table>
inf460 - Security

Module label: Security
Module code: inf460
Credit points: 6.0 KP
Workload: 180 h

Used in course of study:
- 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

Authorized examiners:
- Die im Modul Lehrenden
- Sibylle Fröschle

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

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

Methodological competences:
The students:
- carry out a threat and risk assessment
- formulate security requirements for a given system
- identify and apply standard security solutions to meet them

(These are examples, the exact skills depend on the focus chosen by the student.)

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

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

Module contents:
This module provides a broad and comprehensive knowledge in computer security. The topics cover threat analysis and attack trees, essential cryptographic tools, user authentication, access control, malware, intrusion detection and prevention, denial-of-service attacks and defences, software security and trusted systems, and network security.

Students without prior knowledge in computer security focus on basic principles such as listed above. Students with prior knowledge in computer security can deepen their knowledge by studying real-world examples such as the SSL/TLS protocol. Typically, they will illustrate their topic by discussing a security incident reported in the public domain security news.

Reader’s advisory:
**Language of instruction** | English
---|---
**Duration (semesters)** | 1 Semester
**Module frequency** | once a year
**Module capacity** | unlimited
**Reference text** | Associated with the module(s): Security of Cyber-Physical Systems
**Modullevel** | AS (Akzentsetzung / Accentuation)
**Modulart** | Pflicht o. Wahlpflicht / compulsory or optional
**Lern-Lehrform / Type of program** | V+Ü
**Vorkenntnisse / Previous knowledge** | - Basic knowledge in security
---|---
**Final exam of module** | will be specified in class
**Time of examination** | Presentation and paper, oral exam, or exam (depending on the number of students)
**Course type** | Course or seminar
**SWS** | 2.00
**Frequency** | SuSe
**Workload attendance** | 28 h
inf461 - Security of Cyber-Physical Systems

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<tr>
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<td>Master Informatik &gt; Mastermodule</td>
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<td>Contact person</td>
<td>Module responsibility</td>
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<td>Sibylle Fröschle</td>
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<td>Die im Modul Lehrenden</td>
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<tr>
<td>Authorized examiners</td>
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</tr>
<tr>
<td></td>
<td>Sibylle Fröschle</td>
</tr>
<tr>
<td>Entry requirements</td>
<td>Skills to be acquired in this module</td>
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<td></td>
<td>Professional competences:</td>
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<tr>
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<td>The students:</td>
</tr>
<tr>
<td></td>
<td>- are aware of the threats posed by cyber attacks to cyber-physical systems</td>
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<tr>
<td></td>
<td>- understand security solutions specific to CPS</td>
</tr>
<tr>
<td></td>
<td>- know examples of security architectures of CPS</td>
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<tr>
<td></td>
<td>- 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</td>
</tr>
<tr>
<td></td>
<td>Methodological competences:</td>
</tr>
<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>- carry out a threat and risk assessment for a given CPS</td>
</tr>
<tr>
<td></td>
<td>- formulate security requirements for a given CPS</td>
</tr>
<tr>
<td></td>
<td>- develop a systems security architecture for a given CPS to meet them</td>
</tr>
<tr>
<td></td>
<td>(These are examples, the exact skills depend on the focus chosen by the student.)</td>
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<tr>
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<td>Social competences:</td>
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<td>The students:</td>
</tr>
<tr>
<td></td>
<td>- are able to master a new topic by self-study and interaction with experts and peers</td>
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<td></td>
<td>- are able to explain the significance and facets of security for CPS to experts and non-experts</td>
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<td></td>
<td>- are able to expertly discuss security risks and incidents of CPS</td>
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<td>Self-competences:</td>
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<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>- follow up and critically assess current developments in the security of CPS including relevant security incidents</td>
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<td></td>
<td>- are security aware and foster a security culture with respect to CPS and the resulting critical infrastructures</td>
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<tr>
<td>Module contents</td>
<td>Embedded systems in the energy, transportation, and health domains are currently undergoing a technological transition towards highly networked automated cyber-physical systems (CPS). Such systems are potentially vulnerable to cyber attacks, and these can have physical impact. This includes targeted sabotage of a plant (e.g. Stuxnet), large-scale sabotage of infrastructure to cause economic damage (e.g. attacks against energy grids), and indiscriminate attacks to cause civilian casualties (e.g. by compromise of transportation systems). In this module we investigate and discuss security principles, solutions, and architectures for CPS as well as real-life security incidents. The topics include distance bounding protocols, location tracking and counter-measures, safety and security engineering of CPS, security in the automotive and maritime domain including car hacking and vehicle-2-x communication, hacking in the medical domain, attacks against energy grids, Stuxnet, CPS and society: benefits, risks, acceptance.</td>
</tr>
<tr>
<td>Reader's advisory</td>
<td>Recent scientific papers and reports in the public domain news.</td>
</tr>
<tr>
<td>Links</td>
<td><a href="http://vhome.offis.de/sibyllef">http://vhome.offis.de/sibyllef</a></td>
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<td><strong>Module frequency</strong></td>
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<td><strong>Module capacity</strong></td>
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<td><strong>Modulart</strong></td>
<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
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<td><strong>Lern-Lehrform / Type of program</strong></td>
<td>S or V</td>
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<td><strong>Vorkenntnisse / Previous knowledge</strong></td>
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<tr>
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<th>Type of examination</th>
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<tbody>
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<td>At the end of the lecture period</td>
<td>Presentation and written documentation, oral exam, or exam</td>
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<table>
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<td><strong>Frequency</strong></td>
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<tr>
<td><strong>Workload attendance</strong></td>
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inf522 - Information Processing in Bio-Medical Research

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<tr>
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<td>Master Engineering of Socio-Technical Systems &gt; Human-Computer Interaction</td>
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<td>Master Engineering of Socio-Technical Systems &gt; Systems Engineering</td>
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<td>Master Informatik &gt; Mastermodule</td>
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<td>Module responsibility</td>
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<td></td>
<td>Rainer Röhrig</td>
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<td>Die im Modul Lehrenden</td>
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<tr>
<td>Authorized examiners</td>
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<td></td>
<td>Rainer Röhrig</td>
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<tr>
<td>Entry requirements</td>
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<tr>
<td>Skills to be acquired in this module</td>
<td>The students are aware of the requirements of biomedical research information processing and technologies. They know, develop and evaluate approaches.</td>
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<td></td>
<td>Professional competences:</td>
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<td></td>
<td>The students:</td>
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<tr>
<td></td>
<td>Know the principles of biomedical research and identify resulting requirements and develop appropriate solutions</td>
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<td></td>
<td>Know the regulatory guidelines and assess the suitability of (IT) solutions or develop them</td>
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<td></td>
<td>Plan, apply, evaluate, report and assess IT solution evaluation studies</td>
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<td></td>
<td>Are aware of the biomedical research responsibility and the ethical challenges</td>
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<td></td>
<td>Methodological competences:</td>
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<td>The students:</td>
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<tr>
<td></td>
<td>Search literature systematically</td>
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<td>Plan and assess clinical studies</td>
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<td></td>
<td>Develop concepts for a data privacy and GCP conform study management</td>
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<td></td>
<td>Know and apply medical classification systems</td>
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<td></td>
<td>Validate and run software for clinical trials, cohorts and registries</td>
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<td></td>
<td>Plan and assess healthcare IT studies</td>
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<td>Social competences:</td>
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<td>The students:</td>
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<td></td>
<td>Present solutions/results</td>
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<td>Discuss studies constructively, professionally and appropriately</td>
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<td>Discuss ethical biomedical research problems from different points of view</td>
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<td>Self-competences:</td>
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<td></td>
<td>The students:</td>
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<tr>
<td></td>
<td>Reflect their own values and attitudes in the context of medical and biomedical research border areas</td>
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<td>Reflect their self-capacity with regard to the responsibility and the workload during the implementation of studies and the operation of study information systems</td>
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<td>Module contents</td>
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<tr>
<td></td>
<td>Basics / Biomedical research theory</td>
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<td>Systematic literature research, repositories</td>
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<td></td>
<td>Study schedule and method design</td>
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<td></td>
<td>Biomedical research regulatory framework</td>
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<td></td>
<td>Biomedical research ethics</td>
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<td></td>
<td>IT infrastructure in research / IT components incl. molecular medicine</td>
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<tr>
<td></td>
<td>(Data) privacy</td>
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<tr>
<td></td>
<td>Operating of software for clinical trials, cohorts and registries</td>
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<tr>
<td></td>
<td>Clinical study report standards (Equator-Network), review process</td>
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• Evaluation of healthcare IT (GEP-HI and STARE-HI) / evidence based healthcare informatics

**Reader's advisory**

**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**

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<th>Type of examination</th>
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**Course type**  |  **Comment** |  **SWS** |  **Frequency** |  **Workload attendance** |
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<td>Exercises</td>
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<td>2.00</td>
<td>WiSe</td>
<td>28 h</td>
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**Total time of attendance for the module**  56 h
**Module label**: Medical Software Engineering  
**Module code**: inf523  
**Credit points**: 6.0 KP  
**Workload**: 180 h

### Used in course of study
- 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  
  - Rainer Röhrig

### Entry requirements

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

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

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

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

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

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

### Reader's advisory

### Links

### Languages of instruction
- German, English

### Duration (semesters)
- 1 Semester

### Module frequency
- once a year
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<td>Lern-Lehrform / Type of program</td>
<td>V + Ü</td>
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<td>Vorkenntnisse / Previous knowledge</td>
<td>Medicine for computer scientists Programming skills / software development / information systems / human machine interaction</td>
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<table>
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<th>Time of examination</th>
<th>Type of examination</th>
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<td>Final exam of module</td>
<td>At the end of the lecture periods</td>
<td>written exam</td>
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<table>
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<tbody>
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<td>Lecture</td>
<td></td>
<td>2.00</td>
<td>WiSe</td>
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<tr>
<td>Exercises</td>
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<td>2.00</td>
<td>WiSe</td>
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Total time of attendance for the module 56 h
inf533 - Probabilistic Modelling I

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

Used in course of study:
- Master Eingebettete Systeme und Mikrorobotik > Akzentsetzungsmodule
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Informatik > Mastermodule
- Master Wirtschaftsinformatik > Bereichswahlmodule

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

Authorized examiners:
- Claus Möbus
- Die im Modul Lehrenden

Entry requirements:

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

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

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

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

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

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

Reader's advisory:
Recent eBooks, eTutorials

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

Languages of instruction:
German, English

Duration (semesters):
1 Semester

Module frequency:
jährlich

Module capacity:
unlimited

Reference text:
Associated with the module:
- inf534 Probabilistic Modelling II

Modullevel:
AS (Akzentsetzung / Accentuation)
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# inf537 - Intelligent Systems

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<td></td>
<td>Master Informatik &gt; Mastermodule</td>
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<td>Master Wirtschaftsinformatik &gt; Akzentsetzungsmoduls Bereich Wirtschaftsinformatik</td>
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<tr>
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<td>Module responsibility</td>
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<tr>
<td></td>
<td>● Jürgen Sauer</td>
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<td>● Die im Modul Lehrenden</td>
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<tr>
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<td>Module responsibility</td>
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<td></td>
<td>● Jürgen Sauer</td>
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<tr>
<td></td>
<td>● Die im Modul Lehrenden</td>
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<tr>
<td>Entry requirements</td>
<td>Professional competence</td>
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<tr>
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<td>The students:</td>
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<tr>
<td></td>
<td>● name the structure of agent-based systems</td>
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<td>● use problem-solving methods for complex problems</td>
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<tr>
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<td>● characterise the application area of process planning</td>
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<td></td>
<td>● evaluate the suitability of processes regarding to specific problems</td>
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<td></td>
<td>Methodological competence</td>
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<td>The students:</td>
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<td>● assign problem-solving methods to different problems</td>
</tr>
<tr>
<td></td>
<td>Social competence</td>
</tr>
<tr>
<td></td>
<td>The students:</td>
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<tr>
<td></td>
<td>● implement selected methods in small teams</td>
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<td></td>
<td>Self-competence</td>
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<tr>
<td></td>
<td>The students:</td>
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<tr>
<td></td>
<td>● develop own solutions for given problems</td>
</tr>
<tr>
<td>Module contents</td>
<td>A lot of application areas use &quot;intelligent&quot; 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:</td>
</tr>
<tr>
<td></td>
<td>● A brief introduction into AI</td>
</tr>
<tr>
<td></td>
<td>● Agent systems and</td>
</tr>
<tr>
<td></td>
<td>● Solution methods of AI like heuristics, meta-heuristics, soft computing methods.</td>
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<tr>
<td></td>
<td>To apply and foster the contents of the lecture, an intelligent planning system is implemented in practical exercises.</td>
</tr>
<tr>
<td>Reader's advisory</td>
<td>Suggested reading:</td>
</tr>
<tr>
<td></td>
<td>● Ghallab/ Nau/Traverso: Automated Planning, Morgan Kaufman, 2004</td>
</tr>
<tr>
<td>Links</td>
<td>Languages of instruction</td>
</tr>
<tr>
<td></td>
<td>German, English</td>
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<td>Duration (semesters)</td>
<td>1 Semester</td>
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<tr>
<td>Module capacity</td>
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<tr>
<td>Modullevel</td>
<td>AS (Akzentsetzung / Accentuation)</td>
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<td>Modulart</td>
<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
</tr>
<tr>
<td>Lern-Lehrform / Type of program</td>
<td>V+U</td>
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<td>Vorkenntnisse / Previous knowledge</td>
<td>Produktionsorientierte Wirtschaftsinformatik</td>
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<table>
<thead>
<tr>
<th>Examination</th>
<th>Time of examination</th>
<th>Type of examination</th>
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</thead>
<tbody>
<tr>
<td>Final exam of module</td>
<td>At the end of the lecture period</td>
<td>Exercises and written exam</td>
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<table>
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<tr>
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<th>Comment</th>
<th>SWS</th>
<th>Frequency</th>
<th>Workload attendance</th>
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<tr>
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<td>SuSe</td>
<td>28 h</td>
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<tr>
<td>Exercises</td>
<td></td>
<td>2.00</td>
<td>SuSe</td>
<td>28 h</td>
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Total time of attendance for the module: 56 h
Inf650 - Transport Systems

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

Used in course of study:
- 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:
- Axel Hahn
- Die im Modul Lehrenden

Authorized examiners:
- Axel Hahn
- Die im Modul Lehrenden

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

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

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

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

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

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

Reader's advisory:
Suggested reading:

<table>
<thead>
<tr>
<th>Links</th>
<th><a href="http://wi-ol.de">http://wi-ol.de</a></th>
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<tbody>
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<td>Languages of instruction</td>
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<td>Lern-Lehrform / Type of program</td>
<td>V+Ü</td>
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| Vorkenntnisse / Previous knowledge     | Produktionsorientierte Wirtschaftsinformatik |

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<td>SuSe</td>
<td>28 h</td>
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<tr>
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<td>2.00</td>
<td>SuSe</td>
<td>28 h</td>
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| Total time of attendance for the module | 56 h |

136 / 139
inf903 - Research Project I

Module label: Research Project I
Module code: inf903
Credit points: 12.0 KP
Workload: 360 h

Used in course of study:
- Master Engineering of Socio-Technical Systems > Systems Engineering
- Master Wirtschaftsinformatik > Akzentsetzungsmodule Bereich Wirtschaftsinformatik

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

Entry requirements:

Skills to be acquired in this module:

Ziele des Moduls/Kompetenzen:
The Module practices the scientific competencies in preparation of the master thesis. It is intended to replace the project group with the two "Research Project" modules to ensure studibility and to enable students to perform research projects at foreign universities. Additionally, it is also intended to embed the student into the research activities of the supervisor in preparation of a potential doctoral work after finishing the program.

Professional competences:
The students will extend their competences in the required technologies of the research area.

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

Social competences:
Social competences are extended due to the integration in the working group of the supervisor of the work and include the presentation and discussion of the results within the working group.

Self competences:

- Recognise their abilities and extend them purposefully
- Reflect their self-perception and actions with regard to professional, methodological and social aspects
- Develop and reflect self-developed hypothesis to theories independently
- Work in their field independently

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

Reader's advisory:

Links:
- Languages of instruction: English, German
- Duration (semesters): 1 Semester
- Module frequency: Once a year
- Module capacity: unlimited
- Module level: AS (Akzentsetzung / Accentuation)
- Modulart: Pflicht o. Wahlpflicht / compulsory or optional
- Lern-Lehrform / Type of program: P

Vorkenntnisse / Previous knowledge:

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Course type: Project
SWS: 6.00
Frequency: SuSe and WiSe
Workload attendance: 84 h
### Abschlussmodul

**mam - Master´s Thesis Module**

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<tr>
<th><strong>Module label</strong></th>
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<tr>
<td><strong>Module code</strong></td>
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<td><strong>Credit points</strong></td>
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<td><strong>Used in course of study</strong></td>
<td>Master Engineering of Socio-Technical Systems &gt; Abschlussmodul</td>
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<td><strong>Contact person</strong></td>
<td>Module responsibility</td>
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<td>Lehrende der Informatik</td>
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<td>Authorized examiners</td>
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<td>Lehrende der Informatik</td>
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</tbody>
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**Entry requirements**

**Skills to be acquired in this module**

**Module contents**

**Reader's advisory**

**Links**

**Language of instruction**

**Duration (semesters)**

1 Semester

**Module frequency**

**Module capacity**

unlimited

**Modulart**

je nach Studiengang Pflicht oder Wahlpflicht

**Lern-Lehrform / Type of program**

**Vorkenntnisse / Previous knowledge**

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<td>Final exam of module</td>
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</table>

**Course type**

Seminar

**SWS**

2.00

**Frequency**

SuSe and WiSe

**Workload attendance**

28 h