Inf960 - Fundamental Competences in Computing Science I: Signals and Dynamical Systems

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

**Module code**
inf960

**Credit points**
6.0 KP

**Workload**
180 h

**Applicability of the module**
- Master's Programme Engineering of Socio-Technical Systems (Master) > Fundamentals/Foundations

**Responsible persons**
Lehrenden, Die im Modul (Authorized examiners)
Fränzle, Martin Georg (Module responsibility)
Hein, Andreas (Module responsibility)

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

**Professional competences:**
The students:

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

**Methodological competences:**
The students:

- Get used to specific subjects of signal and image processing

**Social competences:**
The students:

- Present solutions for specific questions in signal and image processing

**Self-competences:**
The students:

- Reflect their solutions by using methods learned in this course

**Module contents**

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

Reader's advisory

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

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 psychology with fundamental competences in computer science and related subjects. This course is also intended for students with a background in computer science lacking prior knowledge in digital signal processing

Modullevel / module level | BC (Basiscurriculum / Base curriculum)
Modulart / typ of module  | Pflicht o. Wahlpflicht / compulsory or optional
Lehr-/Lernform / Teaching/Learning method | V+Ü

Vorkenntnisse / Previous knowledge Modul math040 Analysis II b: Differenzialgleichung mehrerer Variablen

Examination

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Total time of attendance for the module  | 56 h
inf961 - Fundamental Competences in Computing Science II: Mathematics

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<td>Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Fundamentals/Foundations</td>
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<td>Quebbemann, Heinz-Georg (Module responsibility)</td>
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<td>Heß, Florian (Module responsibility)</td>
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<td>Stein, Andreas (Module responsibility)</td>
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<td>Fränzle, Martin Georg (Module responsibility)</td>
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<td>Lehrenden, Die im Modul (Authorized examiners)</td>
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</table>

**Prerequisites**

Skills to be acquired in this module

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

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

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

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

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

**Module contents**

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

The module consists of a lecture and an exercise part.

**Reader's advisory**

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

**Links**

Language of instruction  | English
Duration (semesters)    | 1 Semester
Module frequency         | compulsory
Module capacity          | unlimited

**Reference text**

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

**Modullevel / module level**

BC (Basiscurriculum / Base curriculum)

**Modulart / typ of module**

Pflicht o. Wahlpflicht / compulsory or optional

**Lehr-/Lernform / Teaching/Learning method**

V+Ü

**Vorkenntnisse / Previous knowledge**

**Examination**

Time of examination | Type of examination
--- | ---
At the end of the lecture periods | written exam or oral exam

**Course type**

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

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**Applicability of the module**
- Master's Programme Engineering of Socio-Technical Systems (Master) > Fundamentals/Foundations

**Responsible persons**
- Lehrenden, Die im Modul (Authorized examiners)
- der Informatik, Lehrende (Module responsibility)

**Prerequisites**

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 to structure problems, model problems and solutions, and develop and implement computational solutions. Within the curriculum of the MSc EngSTS, this course provides students featuring a BSc in psychology or related subjects with fundamental skills in computational problem solving that are necessary for mastering subsequent courses in computer science.

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

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

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

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

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

**Reader's advisory**

**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 skills in computational problem solving as necessary for mastering subsequent courses in computer science. This course is not intended for students with a background in computer science.

**Modul.level / module level**
- BC (Basiscurriculum / Base curriculum)

**Modular / typ of module**
- Pflicht o. Wahlpflicht / compulsory or optional

**Lehr-/Lernform / Teaching/Learning method**
- V+Ü

**Vorkenntnisse / Previous knowledge**

**Examination**
- Time of examination: At the end of the lecture period
- Type of examination: Hands-on exercises and written exam or Hands-on exercises and oral exam

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

Module label | Foundations of STS Eng.: Cognitive Processes
Module code | inf963
Credit points | 6.0 KP
Workload | 180 h

Applicability of the module
- Master's Programme Engineering of Socio-Technical Systems (Master) > Fundamentals/Foundations

Responsible persons
- Lehrenden, Die im Modul (Authorized examiners)
- Fränzle, Martin Georg (Module responsibility)

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
Reader's advisory

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<tr>
<td>Language of instruction</td>
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<td>Vorkenntnisse / Previous knowledge</td>
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## inf964 - Foundations of STS Eng.: Psychology and Philosophy of Technology

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<td>Workload</td>
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<td>Applicability of the module</td>
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**Responsible persons**
- Lehrenden, Die im Modul (Authorized examiners)
- Röhrig, Rainer (Module responsibility)

### Prerequisites

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

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

- **Social competences:**
  - Should be able to argue on different point of views based on different

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

### Module contents

- The module consists of a lecture and an seminar part:
  - **Lecture:**
    - Neurocognitive Psychology with emphasis in real world context
    - Ethical Principals an Concepts
    - Forms and Concepts of Technology Assessment
    - Chances and Limitations of Technology Assessment
  - **General:** Presentation as well as critical evaluation and discussion of scientific literature, application of research methods, transfer of scientific paradigms (concepts and methods) to real-world situations.
  - **Seminar:**
    - The students write a thesis for a given technological innovation. In this, various concepts of ethical assessment
and technology assessment are to be applied. The innovation is to be discussed critically from different perspectives. Advantages against disadvantages, benefits against damage, opportunities against dangers, self-interest against common public interest are to be weighed.

**Reader's advisory**


**Links**

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<tr>
<th>Language of instruction</th>
<th>English</th>
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<td>Duration (semesters)</td>
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<td>Module frequency</td>
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<td>Module capacity</td>
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<td>The module will be offered in summer terms and should be completed within one semester. Both parts will run in parallel.</td>
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<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
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<td>Lehr-/Lernform / Teaching/Learning method</td>
<td>V+S</td>
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**Vorkenntnisse / Previous knowledge**

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<td>Final exam of module</td>
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**Total time of attendance for the module**

56 h
inf965 - Foundations of STS Eng.: Systems Engineering

<table>
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<td>Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Fundamentals/Foundations</td>
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**Responsible persons**
- Lehrenden, Die im Modul (Authorized examiners)
- Hahn, Axel (Module responsibility)
- Fränzle, Martin Georg (Module responsibility)

**Prerequisites**

**Skills to be acquired in this module**

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

**Module frequency**
each term

**Module capacity**
unlimited

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

**Modulart / typ of module**
Pflicht o. Wahlpflicht / compulsory or optional

**Lehr-/Lernform / Teaching/Learning method**
V+Ü

**Vorkenntnisse / Previous knowledge**

**Examination**

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<th>SWS</th>
<th>Frequency</th>
<th>Workload of compulsory attendance</th>
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<td>SuSe and WiSe</td>
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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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<td>180 h</td>
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<td>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Fundamentals/Foundations</td>
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<tr>
<td>Responsible persons</td>
<td>Timmer, Antje (Module responsibility)</td>
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<td>Hein, Andreas (Module responsibility)</td>
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<td>Prerequisites</td>
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<td>Skills to be acquired in this module</td>
<td>Professional competences:</td>
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<tr>
<td></td>
<td>The students learn:</td>
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<tr>
<td></td>
<td>To plan, program and interpret statistical data evaluation via programming.</td>
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<td>Methodological competences:</td>
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<td>The students:</td>
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<tr>
<td></td>
<td>• understand the main statistical methods and their practical use through application</td>
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<td></td>
<td>• can evaluate statistical methods regarding the qualities and their limits</td>
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<td></td>
<td>• learn the use of statistical software in application scenarios</td>
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<td></td>
<td>• can implement programs via a programming language</td>
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<td>• know how to program statistical data analyses</td>
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<td>Social competences:</td>
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<td>The students gain experience in interdisciplinary work.</td>
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<td>The students gain experiences in</td>
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<td></td>
<td>• Pursuing goals: Thinking, problem solving and acting</td>
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<tr>
<td></td>
<td>• Ability to analyze and evaluate the effects and relevance of datasets for specific research questions</td>
</tr>
<tr>
<td>Module contents</td>
<td>The module consists of a lecture and an exercise part:</td>
</tr>
<tr>
<td></td>
<td>Lecture: Introduction to the concepts and methods for computer supported statistically data evaluation. Special emphasis is put on statistically methodal as well as on a basic understanding of programming languages.</td>
</tr>
<tr>
<td></td>
<td>1. Fundamental Computer Science Concepts in regard to the handling of imperative programming languages including:</td>
</tr>
<tr>
<td></td>
<td>• variable types and variable handling</td>
</tr>
<tr>
<td></td>
<td>• typical code structures (such as &quot;while / for loops&quot; or &quot;if-then else&quot; statements)</td>
</tr>
<tr>
<td></td>
<td>• data-handling and computation approaches</td>
</tr>
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<td></td>
<td>2. Fundamental static methodology such as:</td>
</tr>
<tr>
<td></td>
<td>• estimating parameters through the method of maximum likelihood</td>
</tr>
<tr>
<td></td>
<td>• confidence intervals and classical significance testing</td>
</tr>
<tr>
<td></td>
<td>• classical regression analysis</td>
</tr>
<tr>
<td></td>
<td>• modern advancements in regression analysis</td>
</tr>
<tr>
<td></td>
<td>Exercises: Stepwise practical or paper based use of the learned concepts, methods and tools.</td>
</tr>
<tr>
<td>Reader's advisory</td>
<td></td>
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<tr>
<td>Links</td>
<td></td>
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<td>Module capacity</td>
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<td>BC (Basiscurriculum / Base curriculum)</td>
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<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
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### Lehr-/Lernform / Teaching/Learning method

V+Ü

### Vorkenntnisse / Previous knowledge

<table>
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### Final exam of module

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<td>Exercises</td>
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<td>2.00</td>
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### Total time of attendance for the module

56 h
### Module Overview

**Module Code:** inf970  
**Module Title:** Fundamental Competences in Psychology I: Psychology  
**Credit Points:** 6.0 KP  
**Workload:** 180 h

**Applicability:** Master's Programme Engineering of Socio-Technical Systems (Master) > Fundamentals/Foundations

**Responsible Persons:**
- Lehrenden, Die im Modul (Authorized examiners)
- Herrmann, Christoph Siegfried (Module responsibility)

**Prerequisites:**

**Skills to be acquired in this module:**

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. It thereby provides students with a background in computer science or a related discipline with fundamental skills in experimental psychology necessary for mastering the subsequent courses from psychology featured in the curriculum.

**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

**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 experimental psychology as necessary for mastering the courses from psychology subsequently featured in the curriculum. This course is not intended for students with a background in psychology.

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

**Modulart / typ of module:** Pflicht o. Wahlpflicht / compulsory or optional

**Lehr-/Lernform / Teaching/Learning method:** V+Ü

### Previous knowledge

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

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<tr>
<td>Credit points</td>
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</table>

**Responsible persons**

Lehrenden, Die im Modul (Authorized examiners)

Thiel, Christiane Margarete (Module responsibility)

**Prerequisites**

Skills to be acquired in this module

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

**Professional competences:**

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

**Methodological competences:**

The students will learn to present and discuss scientific findings

**Social competences:**

The students will learn to interact in a group

**Self-competences:**

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

**Module contents**

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

**Reader's advisory**


**Module frequency**

once a year

**Module capacity**

unlimited

**Reference text**

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

**Links**

Language of instruction: English

Duration (semesters): 1 Semester

Module frequency: once a year

Module capacity: unlimited

**Module level / module level**

BC (Baikurriculum / Base curriculum)

**Modulart / typ of module**

Pflicht o. Wahlpflicht / compulsory or optiona

**Lehr-/Lernform / Teaching/Learning method**

V+S

**Vorkenntnisse / Previous knowledge**

Examination | Time of examination | Type of examination
---|---|---
Final exam of module | March | Written exam

**Course type**

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<tr>
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**Total time of attendance for the module**

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

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<td>Workload</td>
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<td>Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Fundamentals/Foundations</td>
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<td>Responsible persons</td>
<td>Lehrrenden, Die im Modul (Authorized examiners)</td>
</tr>
<tr>
<td></td>
<td>Boll-Westermann, Susanne (Module responsibility)</td>
</tr>
</tbody>
</table>

Prerequisites

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

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

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

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

Skills to be acquired in this module

Professional competences:
- 

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

Social competences:
- 

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

Module contents

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

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

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

Tools
• SoSci Survey for online survey
• Statistic Tools

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

Ethics
• Institutional Review Boards
• Informed Consent

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

**Reader's advisory**

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

**Links**

<table>
<thead>
<tr>
<th>Language of instruction</th>
<th>English</th>
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<td>Module frequency</td>
<td>once a year</td>
</tr>
<tr>
<td>Module capacity</td>
<td>unlimited</td>
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</table>

**Reference text**

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

<table>
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<tr>
<th>Modullevel / module level</th>
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<tbody>
<tr>
<td>Modulart / typ of module</td>
<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
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</table>

**Vorkenntnisse / Previous knowledge**

<table>
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<tr>
<th>Examination</th>
<th>Time of examination</th>
<th>Type of examination</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final exam of module</td>
<td>At the end of the lecture period</td>
<td>practical work and oral exam</td>
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<table>
<thead>
<tr>
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<tr>
<td>Exercises</td>
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<td>2.00</td>
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**Total time of attendance for the module**

56 h
### inf977 - Fundamental Competences in Psychology II: Experimental Psychology (& Cognitive Processes)

<table>
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<th>Fundamental Competences in Psychology II: Experimental Psychology (&amp; Cognitive Processes)</th>
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<tbody>
<tr>
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<tr>
<td>Credit points</td>
<td>6.0 KP</td>
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<td>Workload</td>
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**Applicability of the module**
- Master's Programme Engineering of Socio-Technical Systems (Master) > Fundamentals/Foundations

**Responsible persons**

**Prerequisites**

**Skills to be acquired in this module**

**Module contents**

**Reader's advisory**

**Languages of instruction**
- German, English

**Duration (semesters)**
- 1 Semester

**Module frequency**
- jährlich

**Module capacity**
- unlimited

**Modulart / typ of module**
- Pflicht / Mandatory

**Lehr-/Lernform / Teaching/Learning method**

**Vorkenntnisse / Previous knowledge**

**Final exam of module**

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<td>Lecture</td>
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<td>Seminar</td>
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**Total time of attendance for the module**
- 56 h
**Human-Computer Interaction**

**inf100 - Human Computer Interaction**

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<tr>
<td>Master's Programme Business Informatics (Master) &gt; Akzentsetzungsmodule der Informatik</td>
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<tr>
<td>Master's Programme Computing Science (Master) &gt; Praktische Informatik</td>
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<tr>
<td>Master's Programme Embedded Systems and Microrobotics (Master) &gt; Akzentsetzungsmodule</td>
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<td>Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Embedded Brain Computer Interaction</td>
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**Responsible persons**

Boll-Westermann, Susanne (Authorized examiners)

Lehrenden, Die im Modul (Authorized examiners)

**Prerequisites**

**Skills to be acquired in this module**

**Professional competence**

The students:

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

**Methodological competence**

The students:

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

**Social competence**

The students:

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

**Module contents**

The module introduces the field of human-computer interfaces and their historical context. Moreover, it shows motivating examples of human-computer interaction.

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

**Reader's advisory**

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

**Links**

medien.informatik.uni-oldenburg.de/lehre

**Languages of instruction**

German, English

**Duration (semesters)**

1 Semester

**Module frequency**

once a year

**Module capacity**

unlimited

**Modullevel / module level**

AS (Akzentsetzung / Accentuation)

**Modulart / typ of module**

Pflicht o. Wahlpflicht / compulsory or optional

**Lehr-/Lernform / Teaching/Learning**

V+P
**method**

<table>
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<th>Grundkenntnisse Programmierung</th>
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### Examination

<table>
<thead>
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<th>Type of examination</th>
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<tbody>
<tr>
<td>Final exam of module</td>
<td>Practical group project which progress has to be presented regularly during the tutorials. Oral exam on the topics of the lecture. Practical project and oral exam count 50% each to the final grade. Both practical project and oral exam have to be passed individually.</td>
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</table>

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.

### Course type

<table>
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<tr>
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**Total time of attendance for the module**

56 h
inf131 - Advanced Topics in Human Computer Interaction

<table>
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<tr>
<td>Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Human-Computer Interaction</td>
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Responsible persons
Boll-Westermann, Susanne (Module responsibility)
Lehrenden, Die im Modul (Authorized examiners)

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

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

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

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

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

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

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

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

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

Structure of the Module:

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

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

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

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

Reader's advisory

Suggested reading:


Links

Language of instruction English
Duration (semesters) 1 Semester
Module frequency semi-annual
Module capacity 24
Module level / module level AS (Akzentsetzung / Accentuation)
Moduleart / typ of module Pflicht o. Wahlpflicht / compulsory or optional

Vorkenntnisse / Previous knowledge Interaktive Systeme

Examination

Time of examination Project and oral exams

Final exam of module At the end of the lecture period

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:

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<th>Scored Items</th>
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Total time of attendance for the module 56 h
### inf174 - Special Topics in 'Media Informatics and Multimedia Systems' II

<table>
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<tr>
<th>Module label</th>
<th>Special Topics in 'Media Informatics and Multimedia Systems' II</th>
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<tbody>
<tr>
<td>Module code</td>
<td>inf174</td>
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<tr>
<td>Credit points</td>
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<td>Workload</td>
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</table>
| Applicability of the module                       | Master's Programme Computing Science (Master) > Praktische Informatik  
Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction |
| Responsible persons                               | Boll-Westermann, Susanne (Module responsibility)  
Lehrenden, Die im Modul (Module counselling) |
| Prerequisites                                      |                                                               |
| Skills to be acquired in this module              | This module integrates current developments in the field in adequate study courses. **Professional competences** The students: - Define and contrast a computer science part, in which they are specialised, in detail or evaluate computer science in general - Recognise and evaluate applied techniques and methods of their subject and are aware of their limits - Identify, structure and solve problems/tasks, also in new or developing subject areas - Apply state of the art and innovative methods to solve problems, if necessary from other disciplines - Are aware of the current limits and contribute to the development of computer science research and technology - Discuss and evaluate recent computer science developments **Methodological competences** The students: - Evaluate and apply tools, technology and methods sophisticatedly - Combine new and original approaches and methods creatively - Evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research **Social competences** The students: - Support team process by their abilities **Self-competences** The students: - Pursue the overall and special computer science development critically - Implement innovative professional activities effectively and independently |
| Module contents                                    | According to the assigned course                               |
| Reader's advisory                                  | As announced in course                                        |
| Links                                              |                                                               |
| Languages of instruction                           | German, English                                                |
| Duration (semesters)                               | 1 Semester                                                    |
| Module frequency                                   | irregular                                                     |
| Module capacity                                    | unlimited                                                     |
| Modullevel / module level                          | AC (Aufbaucurriculum / Composition)                           |
| Modulart / typ of module                           | je nach Studiengang Pflicht oder Wahlpflicht                  |
| Lehr-/Lernform / Teaching/Learning method          | 2 Veranst. aus V, S, Ü P, PR                                  |
| Vorkenntnisse / Previous knowledge                |                                                               |
| Examination                                        | Time of examination                                           |
| Final exam of module                               | At the end of the lecture period                              |
| Type of examination                                | Portfolio or presentation or oral exam                        |
| Course type                                        | Course selection                                              |
| SWS                                                | 2.00                                                          |
| Frequency                                          | SuSe or WiSe                                                  |
| Workload attendance                                | 28 h                                                          |
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

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

Responsible persons
- Boll-Westermann, Susanne (Authorized examiners)
- Lehrenden, Die im Modul (Authorized examiners)

Prerequisites

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

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

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

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

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

Module contents
According to the assigned course

Reader's advisory
As announced in course

Links

Languages of instruction
German, English

Duration (semesters)
1 Semester

Module frequency
unregelmäßig

Module capacity
unlimited

Module level / module level
AS (Akzentsetzung / Accentuation)

Modulart / typ of module
je nach Studiengang Pflicht oder Wahlpflicht

Lehr-/Lernform / Teaching/Learning method
2 Veranst. aus V, S, Ü, P, PR (4 SWS)

Vorkenntnisse / Previous knowledge

Examination

Time of examination

Type of examination

Final exam of module
At the end of the lecture period
Exercises or presentation Semesterbegleitende or
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<tr>
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<tr>
<td>Workload attendance</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

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

 Responsible persons:
- Mikschl, Alfred (Authorized examiners)
- Lehrenden, Die im Modul (Authorized examiners)

Prerequisites:
The module provides practical relevance to the design of digital embedded systems.

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

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

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

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

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

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

Languages of instruction:
English, German

Duration (semesters):
1 Semester

Module frequency:
semi-annual

Module capacity:
unlimited

Module level / module level:
AS (Akzentsetzung / Accentuation)

Modular / typ of module:
Pflicht o. Wahlpflicht / compulsory or optional

Teaching/Learning method:
V+P

Vorkenntnisse / Previous knowledge:

Examination:
Time of examination: At the end of the lecture period
Type of examination: Portfolio (Design, development and implementation of embedded systems, colloquium)
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<thead>
<tr>
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<th>Frequency</th>
<th>Workload of compulsory attendance</th>
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inf303 - Fuzzy Control and Artificial Neural Networks in Robotics and Automation

<table>
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Applicability of the module
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering
- Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies

Responsible persons
- Fatikow, Sergej (Authorized examiners)
- Lehrenden, Die im Modul (Authorized examiners)

Prerequisites

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

**Links**

**Languages of instruction**

| English, German |

**Duration (semesters)**

| 1 Semester |

**Module frequency**

| once a year |

**Module capacity**

| unlimited |

**Modullevel / module level**

| AS (Akzentsetzung / Accentuation) |

**Modulart / typ of module**

| Pflicht o. Wahlpflicht / compulsory or optional |

**Lehr-/Lernform / Teaching/Learning method**

| V+U |

**Vorkenntnisse / Previous knowledge**

| Regelungstechnik |

**Examination**

<table>
<thead>
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<td>Hands-on-exercises and oral Exam</td>
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**Course type**

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**Total time of attendance for the module**  
56 h
inf305 - Medical Technology

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

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

Responsible persons:
Hein, Andreas (Authorized examiners)
Lehrenden, Die im Modul (Authorized examiners)

Prerequisites:

Skills to be acquired in this module:

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

Methodological competence
The students:

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

Social competence
The students:

- Present solutions for specific questions

Self-competence
The students:

- reflect their solutions by using methods learned in this course

Module contents:

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

Reader's advisory

essential:
- Lecture slides

recommended:

**secondary literature:**


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**Links**

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<tr>
<td><strong>Module frequency</strong></td>
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<td>AS (Akzentsetzung / Accentuation)</td>
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<td><strong>Modulart / typ of module</strong></td>
<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
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<tr>
<td><strong>Lehr-/Lernform / Teaching/Learning method</strong></td>
<td>V+Ü</td>
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| **Vorkenntnisse / Previous knowledge** | - Signal und Bildverarbeitung  
- Regelungstechnik |

**Examination**

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

**Course type**

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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

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

Responsible persons:
- Lehrenden, Die im Modul (Authorized examiners)
- Hein, Andreas (Authorized examiners)

Prerequisites:

Skills to be acquired in this module:

Professional competence
The students:

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

Methodological competence
The students:

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

Social competence
The students:

- Solve robot systems problems in team work

Self-competence
The students:

- Reflect their solutions in reference to robot system methods

Module contents:

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

seckondary literature:

Links
Languages of instruction
- German
- English

Duration (semesters)
- 1 Semester

Module frequency
- once a year

Module capacity
- unlimited

Modullevel / module level
- AS (Akzentsetzung / Accentuation)

Modulart / typ of module
- Pflicht o. Wahlpflicht / compulsory or optional

Lehr-/Lernform / Teaching/Learning method
- 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 of compulsory attendance
Lecture 3.00 SuSe 42
Exercises 1.00 SuSe 14

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

<table>
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<td>Workload</td>
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**Applicability of the module**

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

**Responsible persons**

Fatikow, Sergej (Authorized examiners)

Lehrenden, Die im Modul (Authorized examiners)

**Prerequisites**

**Skills to be acquired in this module**

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

**Professional competence**

The students:

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

**Methodological competence**

The students:

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

**Social competence**

The students:

- work in a team

**Self-competence**

The students:

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

**Module contents**

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

**Reader's advisory**

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

**Links**
<table>
<thead>
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<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
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Total time of attendance for the module 56 h
inf330 - Embedded Systems

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<td></td>
<td>Nebel, Wolfgang (Authorized examiners)</td>
</tr>
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<td>Fränzle, Martin Georg (Authorized examiners)</td>
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Prerequisites

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

Methods, Oct 1996


Secondary literature:


Links

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Reference text

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

Modullevel / module level  AS (Akzentsetzung / Accentuation)
Modulart / typ of module   Pflicht o. Wahlpflicht / compulsory or optional
Lehr-/Lernform / Teaching/Learning method V+Ü

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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

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

Responsible persons:
Lehrenden, Die im Modul (Authorized examiners)
Köster, Frank (Authorized examiners)

Prerequisites:

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

Professional competences:
The students:
- Discuss different levels/diverse levels sensor-technologies
- Discuss sensor-data fusion (multi-level fusion)
- Discuss Kalman-Filter
- Discuss in-vehicle data-processing
- Discuss 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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### Vorkenntnisse / Previous knowledge

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### Course type

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### Total time of attendance for the module

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inf336 - Application Area Automotive

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

**Responsible persons**
Lehrenden, Die im Modul (Authorized examiners)
Köster, Frank (Authorized examiners)

**Prerequisites**
This module introduces the application area Automotive.

**Skills to be acquired in this module**

**Professional competences:**
- 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:**
- Analyze vehicle systems
- Analyze traffic infrastructure
- Analyze cooperative vehicle/infrastructure systems
- Analyze socio-technical systems

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

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

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

**Reader's advisory**

**Links**
- Language of instruction: English
- Duration (semesters): 1 Semester
- Module frequency: once a year
- Module capacity: unlimited
- Modullevel / module level: AS (Akzentsetzung / Accentuation)
- Modulart / typ of module: Pflicht o. Wahlpflicht / compulsory or optional
- Lehr-/Lernform / Teaching/Learning method: V+Ü

**Vorkenntnisse / Previous knowledge**

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**Total time of attendance for the module**: 56 h
### Design of Autonomous Systems

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

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

**Responsible persons:**  
Lehrenden, Die im Modul (Authorized examiners)  
Fränzle, Martin Georg (Authorized examiners)

**Prerequisites**

**Skills to be acquired in this module**

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

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

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

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

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

**Reader's advisory**

**Links**

**Language of instruction:** English  
**Duration (semesters):** 1 Semester  
**Module frequency:** once a year  
**Module capacity:** unlimited  
**Modullevel / module level:** AS (Akzentsetzung / Accentuation)  
**Modulart / typ of module:** Pflicht o. Wahlpflicht / compulsory or optional  
**Lehr-/Lernform / Teaching/Learning method:** V+Ü

**Vorkenntnisse / Previous knowledge**

**Examination**

**Final exam of module**  
- **Time of examination:** Second half of semester  
- **Type of examination:** Presentation

**Course type**  
- **Comment**  
- **SWS**  
- **Frequency**  
- **Workload of compulsory attendance**

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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

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

Responsible persons:
- Hein, Andreas (Module responsibility)
- Kaspar, Mathias (Module responsibility)
- Lehrenden, Die im Modul (Authorized examiners)

Prerequisites:

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

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

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

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

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

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

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

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

**Responsible persons**
- Hein, Andreas (Module responsibility)
- Kaspar, Mathias (Module responsibility)
- Klausen, Andreas (Module responsibility)
- Lehrenden, Die im Modul (Authorized examiners)
- Röhrig, Rainer (Authorized examiners)

**Prerequisites**

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

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

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

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

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

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

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

**Links**
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inf532 - Introduction to Cognitive Engineering

Module label: Introduction to Cognitive Engineering
Module code: inf532
Credit points: 6.0 KP
Workload: 180 h

Applicability of the module:
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction

Responsible persons:
Feuerstack, Sebastian (Authorized examiners)
Lehrenden, Die im Modul (Authorized examiners)

Prerequisites:

Skills to be acquired in this module:

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

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

Social competences:
The students: --

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

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

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

The module consists of a lecture and an exercise part:

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

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

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 (Christian Wikens, Justin Hollands)
- Ecological Interface design: Progress and challenges. Human Factors (Kim Vicente)
- Cognitive Work Analysis: Toward Safe, Productive, and Healthy Computer-Based Work (Kim Vicente)
- The psychology of Human Computer Interaction (Card, Moran, Newell)

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inf535 - Computational Intelligence I

Module label: Computational Intelligence I
Module code: inf535
Credit points: 6.0 KP
Workload: 180 h

Applicability of the module:
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Environmental Modelling (Master) > Mastermodule

Responsible persons:
Kramer, Oliver (Authorized examiner)
Lehrenden, Die im Modul (Authorized examiner)

Prerequisites:

Skills to be acquired in this module:
Professional competence:
The students:
- recognise optimisation problems
- implement simple algorithms of heuristic optimisation
- critically discuss solutions and selection of methods
- deepen previous knowledge of analysis and linear algebra

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

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

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

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

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

Reader's advisory:

Links
Languages of instruction  English, German
Duration (semesters)  1 Semester
Module frequency  jährlich
Module capacity  unlimited
Module level / module level  AS (Akzentsetzung / Accentuation)
Module type / module level  je nach Studiengang Pflicht oder Wahlpflicht

Teaching/Learning method
Vorkenntnisse / Previous knowledge  - Grundlagen der Statistik
Examination  Time of examination  Type of examination
Final exam of module  At the end of the lecture period  Written or oral exam

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

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

Module label: Computational Intelligence II

Module code: inf536

Credit points: 6.0 KP

Workload: 180 h

Applicability of the module:
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master’s Programme Environmental Modelling (Master) > Mastermodule

Responsible persons:
Lehrenden, Die im Modul (Authorized examiners)
Kramer, Oliver (Authorized examiners)

Prerequisites:

Skills to be acquired in this module:
Professional competence
The students:
- Recognise machine learning problems
- Implement simple algorithms of machine learning
- Critically discuss solutions and selection of methods
- Deepen previous knowledge of analysis and linear algebra

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

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

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

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

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

Reader's advisory:
- HASTIE, T., TIBSHIRANI, R., FRIEDMAN, J.H.: The Elements of Statistical Learning, Springer 2009
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inf537 - Intelligent Systems

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<tr>
<td>Skills to be acquired in this module</td>
<td><strong>Professional competence</strong> 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 <strong>Methodological competence</strong> The students: - assign problem-solving methods to different problems <strong>Social competence</strong> The students: - implement selected methods in small teams <strong>Self-competence</strong> The students: - develop own solutions for given problems</td>
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<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: - 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.</td>
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<td>Links</td>
<td><a href="http://www.wi-ol.de">www.wi-ol.de</a></td>
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<td>Dieses Modul ist im Rahmen der Projekte FiIF und FoL konzipiert worden</td>
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inf551 - Maritime Systems

Module label: Maritime Systems
Module code: inf551
Credit points: 6.0 KP
Workload: 180 h

Applicability of the module:
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodul der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Responsible persons:
Hahn, Axel (Authorized examiners)
Lehrenden, Die im Modul (Authorized examiners)

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

Module contents:

Reader's advisory:

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

Languages of instruction:
German, English

Duration (semesters):
1 Semester

Module frequency:
annually in winterterm

Module capacity:
unlimited

Modulart / typ of module:
Wahlmodul / Opportunity

Lehr-/Lernform / Teaching/Learning method:
V+Ü

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

Examination:

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Course type:

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| Exercises |         | 2.00| WiSe     | 28                                |

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

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

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

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

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

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

| Module contents |

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

| Reader's advisory |

Bernhard Berking, Werner Huth (Herausgeber), Handbuch Nautik 1: Navigationschiffsführung, Seehafen Verlag, 2010

| Links |

Language of instruction: English  
Duration (semesters): 1 Semester  
Module frequency: Once a year  
Module capacity: unlimited  
Modullevel / module level: AS (Akzentsetzung / Accentuation)  
Modulart / typ of module: Pflicht o. Wahlpflicht / compulsory or optional  
Lehr-/Lernform / Teaching/Learning method: V+S

| Vorkenntnisse / Previous knowledge |

| Examination |

Time of examination  
Type of examination

| Final exam of module |

At the end of the lecture period  
Oral exam and documentation

| Course type |

| Lecture |

| Seminar |

| Total time of attendance for the module |

| 56 h |
## inf650 - Transport Systems

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### Applicability of the module
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodul der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

### Responsible persons
- Hahn, Axel (Authorized examiners)
- Lehrenden, Die im Modul (Authorized examiners)

### Prerequisites

### Skills to be acquired in this module

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

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

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

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

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

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

### Reader's advisory
**Suggested reading:**
- Produktion und Logistik (Springer-Lehrbuch) von Hans-Otto Günther und Horst Tempelmeier von
**Links**
http://wi-ol.de

**Languages of instruction**
German, English

**Duration (semesters)**
1 Semester

**Module frequency**
jährlich

**Module capacity**
unlimited

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

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

**Modulart / typ of module**
je nach Studiengang Pflicht oder Wahlpflicht

**Lehr-/Lernform / Teaching/Learning method**
V+Ü

**Vorkenntnisse / Previous knowledge**
Produktionsorientierte Wirtschaftsinformatik

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**Total time of attendance for the module**
56 h
**inf339 - Industrie 4.0: Digitalisierung der industriellen Produktion**

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

### Responsible persons

### Skills to be acquired in this module

### Module contents

### Reader's advisory

### Links

### Language of instruction
German

### Duration (semesters)
1 Semester

### Module frequency

### Module capacity
unlimited

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

### Modultyp / typ of module
Wahlpflicht / Elective

### Lehr-/Lernform / Teaching/Learning method

### Vorkenntnisse / Previous knowledge

### Examination

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**Total time of attendance for the module**

56 h
inf460 - Security

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

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

Responsible persons:
Lehrenden, Die im Modul (Authorized examiners)
Fröschle, Sibylle (Authorized examiners)

Prerequisites:

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

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

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

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

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

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

Reader’s advisory:

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

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

Modulart / typ of module: Pflicht o. Wahlpflicht / compulsory or optional

Lehr-/Lernform / Teaching/Learning method: S or V

Vorkenntnisse / Previous knowledge:
- Basic knowledge in security

Examination:
- Time of examination: will be specified in class
- Type of examination: Presentation and paper, oral exam, or exam (depending on the number of students)

Course type: Course or seminar

SWS: 2.00
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inf461 - Security of Cyber-Physical Systems

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

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

Responsible persons:
Lehrenden, Die im Modul (Authorized examiners)
- Fröschle, Sibylle (Authorized examiners)

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

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

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

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

Language of instruction:
English

Duration (semesters):
1 Semester

Module frequency:
Once a year

Module capacity:
Unlimited

Module level / module level:
AS (Akzentsetzung / Accentuation)

Modulart / typ of module:
Pflicht o. Wahlpflicht / compulsory or optional

Lehr-/Lernform / Teaching/Learning method:
S or V

Vorkenntnisse / Previous knowledge:

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

Course type:
Course or seminar

SWS:
2.00

Frequency:
SuSe or WiSe

Workload attendance:
28 h
inf604 - Business Intelligence I

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Workload 180 h

Applicability of the module
- Master of Education Programme (Vocational and Business Education) Computing Science (Master of Education) > Mastermodule
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Responsible persons
Marx Gomez, Jorge (Authorized examiners)
Lehrenden, Die im Modul (Authorized examiners)

Prerequisites

Skills to be acquired in this module
Objective of the module/skills:
Current module provides basics of business intelligence with focus on enterprises and strong emphasis on data warehousing technologies. Students of the course are provided with knowledge, which reflects current research and development in a data analytic domain.

Professional competence
The students:
- name and recognize the role of business intelligence as part of daily business process
- being able to analyse advantages and disadvantages of different approaches and methods of the data analytics and being able to apply them in simple case studies
- obtain theoretical knowledge about data collection and modelling processes, including most applicable approaches and best practices

Methodological competence
The students:
- being able to execute typical tasks of business intelligence, and also being able to deepen knowledge on different approaches and methods
- gain a hands on experience and being able to understand advantages and disadvantages of different methods and being able to use obtained knowledge in most efficient ways

Social competence
The students:
- build solutions based on case studies given to the group, for example solving the issue of a factless fact table
- discuss solutions on a technical level
- present obtained case studies solutions as part of the exercises

Self-competence
The students:
- critically review provided data and information

Module contents
Data warehouse technology together with business intelligence are increasingly being used by business in order to get better decision support and enrich ongoing processes with data-rich decisions. Data warehouse technology enables an integration of data from heterogeneous sources, whether business intelligence builds data processing on top of it. For instance, business intelligence allows to build reporting on very large volumes of data (including historical) coming primary from data warehouse.

As past of the current module following contents are taught:
- Definition and scope of business intelligence.
- Procedures and objectives of data warehousing.
- Process of extracting, transforming and loading (ETL) of data.
Phases of data modelling, data capturing and reporting in conjunction with a plausible case studies/scenarios.
Prospects for further and evolving topics for business intelligence (e.g., Adaptive Business Intelligence, In-Memory Computing, etc.).
Introduction to Data Mining.
Case studies based practical exercises and assessments in order to impart practical knowledge.

**Reader's advisory**

- Marx Gómez, Rautenstrauch, Cissek (2008): Einführung in die Business Intelligence mit SAP NetWeaver 7.0.

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

**Languages of instruction**
German, English

**Duration (semesters)**
1 Semester

**Module frequency**
jährlich

**Module capacity**
unlimited

**Modullevel / module level**
AS (Akzentsetzung / Accentuation)

**Modulart / typ of module**
Wahlpflicht / Elective

**Lehr-/Lernform / Teaching/Learning method**
V + Ü

**Vorkenntnisse / Previous knowledge**

**Examination**
**Time of examination**
At the end of the lecture period
**Type of examination**
Written exam max. 120 minutes

**Course type**
**Comment**
**SWS**
**Frequency**
**Workload of compulsory attendance**

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**Total time of attendance for the module**
56 h
inf607 - Business Intelligence II

Module label | Business Intelligence II
---|---
Module code | inf607
Credit points | 6.0 KP
Workload | 180 h

Applicability of the module
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Responsible persons
Marx Gomez, Jorge (Authorized examiners)
Lehrenden, Die im Modul (Authorized examiners)

Prerequisites

Skills to be acquired in this module
Current module provides advanced business intelligence, data science with focus on enterprises and strong emphasis on big data and data analytics. Students of the course are provided with knowledge, which reflects current research and development in a data analytics domain.

Professional competence
The students:
- name and recognize the role of data analytics / data science as past of a daily business process in a particular company
- able to organize from managment perspective data analytics project
- being able to analyse advantages and disadvantages of different approaches and methods of the data analytics and being able to apply them in simple case studies
- obtain theoretical knowledge about data collection and modelling processes, including state of the art approaches and available best practices

Methodological competence
The students:
- being able to execute typical tasks of data analytics, and also being able to proceed deeper with respect to different approaches and methods
- gain a hands on experience and being able to understand advantages and disadvantages of different methods and being able to use obtained knowledge

Social competence
The students:
- build solutions based on case studies given to the group, for example design of regression model based on provided dataset
- discuss solutions on a technical level
- present obtained case studies solutions as part of the exercises

Self-competence
The students:
- critically review provided offered information

Module contents
After current course students will get advanced knowledge in the domains such as business intelligence and data analytics. Besides that, students will have a chance to have a deeper look into related technical fields such as InMemory Computing, Data Mining and Machine Learning, Big Data Processing with Distributed Systems (e.g. Apache Hadoop / Spark) from both, research and practical, perspectives. Students will be provided with real-world experience gather from business intelligence and data science related projects. Materials of the course are believed to be justified with current demands of data analytics market. Thus, providing students with relevant knowledge in order to give them advantages in future job.

Reader's advisory
- Jürgen Cleve, Uwe Lämmel (2014): "Data mining" (Deutsch)
- Max Bramer (2013): "Principles of data mining" (English)
- Ian Witten, Eibe Frank, Mark Hall (2011): "Data mining : practical machine learning tools and techniques" (English)
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Vorkenntnisse / Previous knowledge

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

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**Applicability of the module**
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

**Responsible persons**
- Hahn, Axel (Authorized examiners)
- Lehrenden, Die im Modul (Authorized examiners)

**Prerequisites**

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

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

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

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

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

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

**Reader's advisory**
- Ehrlenspiel (2003): Integrierte Produktentwicklung

**Links**
www.wi-ol.de
<table>
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### Previous knowledge

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<td>Written exam or oral exam, or written documentation or Presentation or Portfolio</td>
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Total time of attendance for the module: 56 h
mar364 - Time Series Analysis

Module label Time Series Analysis
Module code mar364
Credit points 6.0 KP
Workload 180 h
(Präsenzzeit: 56 Stunden, Selbststudium: 124 Stunden)

Applicability of the module
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering
- Master's Programme Environmental Modelling (Master) > Mastermodule
- Master's Programme Marine Environmental Sciences (Master) > Mastermodule
- Master's Programme Marine Sensors (Master) > Mastermodule

Responsible persons
Freund, Jan (Authorized examiners)

Prerequisites
Keine

Skills to be acquired in this module
VL/Ü Zeitreihenanalyse
Die Studenten besitzen die Fähigkeit Zeitreihen zu visualisieren und mit Standardmethoden der Zeitreihenanalyse zu analysieren. Sie können Zeitreihen als im Meßprozeß verrauschte Realisierungen unterliegender stochastischer Prozesse auffassen und sind in der Lage, Schätzer mit ihren wesentlichen Merkmalen (Verzerrung, Konsistenz und Effizienz, Verteilung) sicher zu handhaben und die Resultate zuverlässig zu interpretieren.
Sie können reale Zeitreihen im Kontext wissenschaftlicher Qualitätsanforderungen bewerten, transformieren/bereinigen/modifizieren und analysieren bzw. für anschließende Analysen aufbereiten.

Module contents
VL Zeitreihenanalyse
Charakteristika eines stochastischen Prozesses und deren Schätzer, Komponentenmodell, Trendbereinigung, spektrale Methoden, Filterung, lineare und nichtlineare Prozesse, Einbettungsverfahren, Kenngrößen der nichtlinearen Zeitreihenanalyse, symbolische Dynamik
Ü Zeitreihenanalyse
Vertiefung der Inhalte der zugehörigen VL sowie praktische Übungen

Reader's advisory
R. Schlittgen: Angewandte Zeitreihenanalyse mit R. Oldenbourg;
R. Schlittgen & B. Streilberg: Zeitreihenanalyse. Oldenbourg;
PJ Brockwell & RA Davis: Time series : theory and methods, Springer;

Links
Languages of instruction German, English
Duration (semesters) 1 Semester
Module frequency
Module capacity unlimited
Modullevel / module level MM (Mastermodul / Master module)
Modulart / typ of module Wahlpflicht / Elective
Lehr-/Lernform / Teaching/Learning method Sommersemester:
- VL Zeitreihenanalyse (2 SWS, 3 KP)
- Ü Zeitreihenanalyse (2 SWS, 3 KP)
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**Total time of attendance for the module** 56 h
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| Applicability of the module | • Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction  
• Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction  
• Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering |
| Responsible persons |                                            |
| Prerequisites |                                            |
| Skills to be acquired in this module |                                            |
| Module contents |                                            |
| Reader's advisory |                                            |
| Links |                                            |
| Language of instruction | German                                    |
| Duration (semesters) | 1 Semester                                |
| Module frequency |                                            |
| Module capacity | unlimited                                 |
| Modullevel / module level | MM (Mastermodul / Master module)          |
| Modulart / typ of module | Wahlpflicht / Elective                    |
| Lehr-/Lernform / Teaching/Learning method |                                            |
| Vorkenntnisse / Previous knowledge |                                            |
| Examination | Time of examination | Type of examination |
| Final exam of module | KL                                        |
| Course type | Seminar                                   |
| SWS | 4.00                                      |
| Frequency | WiSe                                     |
| Workload attendance | 56 h                                      |
Embedded Brain Computer Interaction

inf100 - Human Computer Interaction

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<td>Responsible persons</td>
<td>Boll-Westermann, Susanne (Authorized examiners)</td>
</tr>
<tr>
<td></td>
<td>Lehrenden, Die im Modul (Authorized examiners)</td>
</tr>
<tr>
<td>Prerequisites</td>
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<tr>
<td>Skills to be acquired in this module</td>
<td>Professional competence</td>
</tr>
<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>Name the human-computer interaction core principles</td>
</tr>
<tr>
<td></td>
<td>Characterise the basic elements of the human-centered design of interactive systems</td>
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<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>Comprehend context of use and user requirements of human-machine interfaces</td>
</tr>
<tr>
<td></td>
<td>Design, develop and evaluate human-machine interfaces</td>
</tr>
<tr>
<td></td>
<td>Conduct experiments with their prototypes</td>
</tr>
<tr>
<td></td>
<td>Social competence</td>
</tr>
<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>Implement human-computer interfaces in practical hands-on projects in teams</td>
</tr>
<tr>
<td></td>
<td>Evaluate human-machine interfaces with potential users</td>
</tr>
<tr>
<td></td>
<td>Develop and present solutions for Human-Computer Interaction related problems</td>
</tr>
<tr>
<td></td>
<td>Integrate technical and factual comments into own results</td>
</tr>
<tr>
<td>Module contents</td>
<td>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.</td>
</tr>
<tr>
<td>Links</td>
<td>medien.informatik.uni-oldenburg.de/lehre</td>
</tr>
<tr>
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<td>AS (Akzentsetzung / Accentuation)</td>
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<td>Modulart / typ of module</td>
<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
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<td>Lehr-/Lernform / Teaching/Learning</td>
<td>V+P</td>
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method

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<th>Vorkenntnisse / Previous knowledge</th>
<th>Grundkenntnisse Programmierung</th>
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<tr>
<td>Examination</td>
<td>Time of examination</td>
</tr>
<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>

<table>
<thead>
<tr>
<th>Course type</th>
<th>Comment</th>
<th>SWS</th>
<th>Frequency</th>
<th>Workload of compulsory attendance</th>
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<td></td>
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# inf300 - Hybrid Systems

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<tr>
<td>Module code</td>
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<tr>
<td>Credit points</td>
<td>6.0 KP</td>
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<td>Workload</td>
<td>180 h</td>
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</table>

## Applicability of the module

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

## Responsible persons

Fränzle, Martin Georg (Authorized examiners)

## Prerequisites


## 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

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Languages of instruction</td>
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<tr>
<td>Module type / typ of module</td>
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<tr>
<td>Lehr-/Lernform / Teaching/Learning method</td>
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| Vorkenntnisse / Previous knowledge        | Bachelor in Computing Science oder Kenntnisse gewöhnlicher Differentialgleichungen |
| Examination                               | Time of examination                      | Type of examination |
| Final exam of module                      | At the end of the lecture period          | Semester project including written work and final presentation |

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| Total time of attendance for the module  | 56 h |

1 Semester
inf301 - Machine-oriented Systems Engineering

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

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

Responsible persons:
Mikschl, Alfred (Authorized examiners)
Lehrenden, Die im Modul (Authorized examiners)

Prerequisites:

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

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

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

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

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

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

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

Languages of instruction: English, German
Duration (semesters): 1 Semester
Module frequency: semi-annual
Module capacity: unlimited

Module level / module level: AS (Akzentsetzung / Accentuation)
Moduleart / typ of module: Pflicht o. Wahlpflicht / compulsory or optional
Lehr-/Lernform / Teaching/Learning method: V+P

Vorkenntnisse / Previous knowledge

Examination:
Time of examination: Time of examination
Type of examination: Portfolio (Design, development and implementation of embedded systems, colloquium)
<table>
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<th>SWS</th>
<th>Frequency</th>
<th>Workload of compulsory attendance</th>
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<td></td>
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inf303 - Fuzzy Control and Artificial Neural Networks in Robotics and Automation

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<tr>
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<td>Credit points</td>
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<tr>
<td>Workload</td>
<td>180 h</td>
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</table>
| Applicability of the module | - Master's Programme Computing Science (Master) > Angewandte Informatik  
- Master's Programme Computing Science (Master) > Technische Informatik  
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule  
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction  
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction  
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering  
- Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies |

Responsible persons
Fatikow, Sergej (Authorized examiners)
Lehrrenden, Die im Modul (Authorized examiners)

Prerequisites

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 AM&R
- 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:

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

Secondary Literature:

• Altrock, M. O. R.: Fuzzy Logic, R. Oldenbourg Verlag, 1993
• Kahler, J. und Hubert, F.: Fuzzy-Logik und Fuzzy-Control, Vieweg, 1993
• Krämer, K.P.: Neuronale Netze, Carl Hanser, 1993
• Lawrence, J.: Neuronale Netze, Syntagma Verlag, München, 1992
• Omidvar, O. and van der Smagt, P. (eds.): Neural Networks for Robotics, Academic Press, 1997
• Patterson, D.W.: Künstliche neuronale Netze, Prentice Hall, 1996
• Pham, D.T. a200
• nd Liu, X.: Neural Networks for Identification, Prediction and Control, Springer, 1997
• Schulte, U.: Einführung in Fuzzy-Logik, Franzis-Verlag, München, 1993
• von Altrock, C.: Fuzzy Logic: Technologie, Oldenbourg, 1993
• Zakharian, S. Ladewig-Riebler, P. und Thoer, St.: Neuronale Netze für Ingenieure, Vieweg, Wiesbaden, 1998
• Zimmermann H.-J. (Hrsg.): Datenanalyse, VDI-Verlag, 1995
• Zimmermann, H.-J. (Hrsg.): Neuro + Fuzzy: Technologien und Anwendungen, VDI-Verlag, 1995

Links

Languages of instruction English, German
Duration (semesters) 1 Semester
Module frequency once a year
Module capacity unlimited
Modullevel / module level AS (Akzentsetzung / Accentuation)
Modulart / typ of module Pflicht o. Wahlpflicht / compulsory or optional
Lehr-/Lernform / Teaching/Learning method V+Ü
Vorkenntnisse / Previous knowledge Regelungstechnik
Examination Time of examination Type of examination
Final exam of module At the end of the lecture period until the beginning of the next semester Hands-on-exercises and oral Exam
Course type Comment SWS Frequency Workload of compulsory attendance

80 / 198
<table>
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<td></td>
<td></td>
<td><strong>56 h</strong></td>
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</table>
inf305 - Medical Technology

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

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

Responsible persons:
Hein, Andreas (Authorized examiners)
Lehrenden, Die im Modul (Authorized examiners)

Prerequisites:

Skills to be acquired in this module:

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

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

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

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

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

Reader's advisory:

essential:
- Lecture slides

recommended:
• Dugas, M.; Schmidt, K.: Medizinische Informatik und Bioinformatik. Springer Verlag, 2003

**secondary literature:**


<table>
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<td>Duration (semesters)</td>
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<td>Module frequency</td>
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<td>Module capacity</td>
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<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
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<td>Lehr-/Lernform / Teaching/Learning method</td>
<td>V+Ü</td>
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<td>Previous knowledge - Signal und Bildverarbeitung</td>
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<td>Previous knowledge - Regelungstechnik</td>
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**Examination**

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

**Course type**

<table>
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<tr>
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<th>Frequency</th>
<th>Workload of compulsory attendance</th>
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**Total time of attendance for the module**

56 h
inf307 - Robotics

<table>
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<tr>
<th>Module label</th>
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<tr>
<td>Module code</td>
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<tr>
<td>Credit points</td>
<td>6.0 KP</td>
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<tr>
<td>Workload</td>
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Applicability of the module

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

Responsible persons

- Lehrenden, Die im Modul (Authorized examiners)
- Hein, Andreas (Authorized examiners)

Prerequisites

Skills to be acquired in this module

**Professional competence**

The students:

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

**Methodological competence**

The students:

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

**Social competence**

The students:

- Solve robot systems problems in team work

**Self-competence**

The students:

- Reflect their solutions in reference to robot system methods

Module contents

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

**sekundäre literature:**

**Links**
Languages of instruction
- German, English

Duration (semesters)
- 1 Semester

Module frequency
- once a year

Module capacity
- unlimited

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

Module / type of module
- Pflicht o. Wahlpflicht / compulsory or optional

Lehr-/Lernform / Teaching/Learning method
- 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

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

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**Applicability of the module**

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

**Responsible persons**

Fatikow, Sergej (Authorized examiners)

Lehrenden, Die im Modul (Authorized examiners)

**Prerequisites**

**Skills to be acquired in this module**

After having given an established introduction in the module "Microrobotics and Microsystems 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 microrobotics 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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<table>
<thead>
<tr>
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<th>English, German</th>
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<tr>
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inf311 - Low Energy System Design

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**Applicability of the module**

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

**Responsible persons**

Lehrenden, Die im Modul (Authorized examiners)

Nebel, Wolfgang (Authorized examiners)

**Prerequisites**

This module introduces the estimation of power dissipation and optimisation.

**Skills to be acquired in this module**

**Professional competence**

The students:

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

**Methodological competence**

The students:

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

**Social competence**

The students:

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

**Self-competence**

The students:

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

**Module contents**

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

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

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

This module introduces the estimation of power dissipation and optimisation.

**Reader's advisory**

- Designing CMOS Circuits for Low Power – Dimitros Soudris, Christian Piguet, Costas Goutis
- Low-Power CMOS VLSI Circuit Design – Kaushik Roy, Sharat C. Prasad
- Low-Power Electronics Design – Christian Piguet et al.
- Leakage in Nanometer CMOS Technologies – Siva G. Narendra, Anantha Chandrakasan
- Entwurf von digitalen Schaltungen und Systemen mit HDLs und FPGAs – F. Kesel, R. Bartholomä
- Slides of the module „Eingebettete Systeme I+II“ von Professor Dr.-Ing. Wolfgang Nebel
- Slides and technical readouts of the used hardware and development tools
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| **Previous knowledge**       | - inf200 Grundlagen der Technische Informatik,  
                              - inf201 Technische Informatik, 
                              - inf203 Eingebettete Systeme I+, 
                              - inf204 Eingebettete Systeme II |
| **Final exam of module**     | at the end of the lecture period  
                              | hands-on exercises and oral exam |
| **Course type**              | **Comment**    | **SWS** | **Frequency** | **Workload of compulsory attendance** |
| Lecture                      |                | 2.00    | WiSe          | 28 |
| Exercises                    |                | 2.00    | WiSe          | 28 |
| **Total time of attendance for the module** | 56 h |
inf31 - Automated and Connected Driving

Module label: Automated and Connected Driving
Module code: inf31
Credit points: 6.0 KP
Workload: 180 h

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

Responsible persons
Köster, Frank (Authorized examiners)
Lehrenden, Die im Modul (Authorized examiners)

Prerequisites

Skills to be acquired in this module

This module introduces the principles of automated driving.

Professional competences:
The students:
- Discuss different levels of automated driving (e.g., 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 (e.g., 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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<td>V+Ü</td>
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<td>Praktical work and oral exam</td>
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<td>SuSe</td>
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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

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

Responsible persons
Lehrenden, Die im Modul (Authorized examiners)
Hein, Andreas (Authorized examiners)

Prerequisites

Skills to be acquired in this module

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

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

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

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

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

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
Modullevel / module level | AS (Akzentsetzung / Accentuation)
Modulart / typ of module | Pflicht o. Wahlpflicht / compulsory or optional
Lehr-/Lernform / Teaching/Learning method | V+Ü

Vorkenntnisse / Previous knowledge

Examination | Time of examination | Type of examination
Final exam of module | At the end of the lecture period | Demonstration and written documentation

Course type | Comment | SWS | Frequency | Workload of compulsory attendance
Lecture | 2.00 | SuSe or WiSe | 28
Exercises | 2.00 | SuSe or WiSe | 28
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inf333 - Sensor Technology in the Automotive Domain

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

**Responsible persons**
- Lehrenden, Die im Modul (Authorized examiners)
- Köster, Frank (Authorized examiners)

**Prerequisites**

**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 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:**
<table>
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**Vorkenntnisse / Previous knowledge**

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<td>Practikal Work and oral exam</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

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

**Responsible persons**
Lehrenden, Die im Modul (Authorized examiners)
Grüttner, Kim (Authorized examiners)

**Prerequisites**

**Skills to be acquired in this module**

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

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

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

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

**Module contents**

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

This module builds on the modules Embedded Systems I and II, deepens the knowledge acquired there for the design of hardware/software systems and expands them with current methods and tools. With SystemC, a language is presented that is already widely used in industry and research for the design and verification of hardware/software systems and supports several abstraction levels from clock cycle accurate hardware description, over transaction level models to process based functional specifications.
### 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/](https://www.uni-oldenburg.de/informatik/ehs/lehre/vorlesungen/system-level-design/)

#### Language of instruction

- English

#### Duration (semesters)

- 1 Semester

#### Module frequency

- once a year

#### Module capacity

- unlimited

#### Module level / module level

- AS (Akzentsetzung / Accentuation)

#### Modulart / typ of module

- Pflicht o. Wahlpflicht / compulsory or optional

#### Lehr-/Lernform / Teaching/Learning method

- V+Ü

#### Vorkenntnisse / Previous knowledge

#### Examination

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#### Course type

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#### Total time of attendance for the module

- 56 h
inf335 - Strategy Synthesis

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

**Responsible persons**
Lehrenden, Die im Modul (Authorized examiners)

**Prerequisites**

**Skills to be acquired in this module**

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

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

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

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

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

**Reader's advisory**
Suggested reading:

Links

Language of instruction | English
Duration (semesters) | 1 Semester
Module frequency | once a year
Module capacity | unlimited
Modullevel / module level | AS (Akzentsetzung / Accentuation)
Modulart / typ of module | Pflicht o. Wahlpflicht / compulsory or optional
Lehr-/Lernform / Teaching/Learning method | V+Ü

Vorkenntnisse / Previous knowledge

Examination | Time of examination | Type of examination
Final exam of module | At the end of the lecture period | Written or oral exam

Course type | Comment | SWS | Frequency | Workload of compulsory attendance
Lecture | 2.00 | SuSe and WiSe | 28
Exercises | 2.00 | SuSe and WiSe | 28

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

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

Responsible persons:
Lehrenden, Die im Modul (Authorized examiners)
Köster, Frank (Authorized examiners)

Prerequisites:
This module introduces the application area Automotive.

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

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

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

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

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

Reader's advisory:

Links:
Language of instruction: English
Duration (semesters): 1 Semester
Module frequency: once a year
Module capacity: unlimited
Module level / module level: AS (Akzentsetzung / Accentuation)
Modulart / typ of module: Pflicht o. Wahlpflicht / compulsory or optional
Lehr-/Lernform / Teaching/Learning method: V+Ü

Vorkenntnisse / Previous knowledge:

Examination:
Time of examination:
Type of examination: Practical Work and oral Exam

Final exam of module:
At the end of the lecture period
Course type:
Comment
SWS
Frequency
Workload of compulsory attendance
Lecture 2.00 SuSe 28
Exercises 2.00 SuSe 28

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

<table>
<thead>
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<th>Module label</th>
<th>Design of Autonomous Systems</th>
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</thead>
<tbody>
<tr>
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<td>inf338</td>
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<tr>
<td>Credit points</td>
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</table>

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

**Responsible persons**
- Lehrende, Die im Modul (Authorized examiners)
  - Fränzle, Martin Georg (Authorized examiners)

**Prerequisites**

**Skills to be acquired in this module**

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

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

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

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

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

**Reader's advisory**

**Links**

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

**Modullevel / module level**: AS (Akzentsetzung / Accentuation)

**Modulart / typ of module**: Pflicht o. Wahlpflicht / compulsory or optional

**Lehr-/Lernform / Teaching/Learning method**: V+Ü

**Vorkenntnisse / Previous knowledge**

**Examination**

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**Final exam of module**

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<tbody>
<tr>
<td>Lecture</td>
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<tr>
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<td>2.00</td>
<td>W1Se</td>
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**Total time of attendance for the module**: 56 h
inf456 - Real-Time Systems

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

**Responsible persons**
Lehrenden, Die im Modul (Authorized examiners)
Olderog, Ernst-Rüdiger (Authorized examiners)

**Prerequisites**

**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

essential:

recommended:

Links

Languages of instruction  German, English
Duration (semesters)  1 Semester
Module frequency  irregular
Module capacity  unlimited
Module level / module level  AS (Akzentsetzung / Accentuation)
Modulart / typ of module  Pflicht o. Wahlpflicht / compulsory or optional
Lehr-/Lernform / Teaching/Learning method  V+Ü
Vorkenntnisse / Previous knowledge  Theoretische Informatik I + II
Examination  Time of examination  Type of examination
Final exam of module  At the end of the lecture period  Exercises and written or oral exam

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

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

**Responsible persons**
- Lehrenden, Die im Modul (Authorized examiners)
- Fröschle, Sibylle (Authorized examiners)

**Prerequisites**

**Skills to be acquired in this module**

**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

**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

**Modulart / typ of module**

Pflicht o. Wahlpflicht / compulsory or optional

**Lehr-/Lernform / Teaching/Learning method**

S or V

**Vorkenntnisse / Previous knowledge**

- Basic knowledge in security

**Examination**

<table>
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<th>Type of examination</th>
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<td>Presentation and paper, oral exam, or exam (depending on the number of students)</td>
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**Course type**

Course or seminar

**SWS**

2.00
| Frequency     | SuSe | Workload attendance | 28 h |
inf523 - Medical Software Engineering

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

### Responsible persons
- Hein, Andreas (Module responsibility)
- Kaspar, Mathias (Module responsibility)
- Klausen, Andreas (Module responsibility)
- Lehrenden, Die im Modul (Authorized examiners)
- Röhrig, Rainer (Authorized examiners)

### Prerequisites

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

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

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

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

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

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

### Reader's advisory
wird im Modul bekannt gegeben

### Links

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<table>
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<td>Duration (semesters)</td>
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<td>Module frequency</td>
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<td>Module capacity</td>
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<td>Module level / module level</td>
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<td>V + Ü</td>
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<td>Previous knowledge</td>
<td>Medizin für Informatiker Programierkenntnisse / Softwareentwicklung / Informationssysteme / Mensch Maschine Interaktion</td>
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<td>Examination</td>
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<tr>
<td>Final exam of module</td>
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<tr>
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**inf461 - Security of Cyber-Physical Systems**

<table>
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<tr>
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<td>Master’s Programme Computing Science (Master) &gt; Theoretische Informatik</td>
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<tr>
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<tr>
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<td>Master’s Programme Engineering of Socio-Technical Systems (Master) &gt; Systems Engineering</td>
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<tr>
<td>Responsible persons</td>
<td>Lehrenden, Die im Modul (Authorized examiners)</td>
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<td>Fröschle, Sibylle (Authorized examiners)</td>
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<tr>
<td>Skills to be acquired in this module</td>
<td></td>
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<tr>
<td><strong>Professional competences:</strong> The students: - are aware of the threats posed by cyber attacks to cyber-physical systems - understand security solutions specific to CPS - know examples of security architectures of CPS - are able to apply this knowledge to assess the risk of cyber attacks to a given CPS as well as to develop a conceptual systems security architecture for it <strong>Methodological competences:</strong> The students: - carry out a threat and risk assessment for a given CPS - formulate security requirements for a given CPS - develop a systems security architecture for a given CPS to meet them (These are examples, the exact skills depend on the focus chosen by the student.) <strong>Social competences:</strong> The students: - are able to master a new topic by self-study and interaction with experts and peers - are able to explain the significance and facets of security for CPS to experts and non-experts - are able to expertly discuss security risks and incidents of CPS <strong>Self-competences:</strong> The students: - follow up and critically assess current developments in the security of CPS including relevant security incidents - are security aware and foster a security culture with respect to CPS and the resulting critical infrastructures</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>
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<tr>
<td>Links</td>
<td><a href="http://vhome.offis.de/sibyllef">http://vhome.offis.de/sibyllef</a></td>
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<td>S or V</td>
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<td>Examination</td>
<td>Time of examination</td>
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<tr>
<td>Final exam of module</td>
<td>At the end of the lecture period</td>
</tr>
<tr>
<td></td>
<td>Presentation and written documentation, oral exam, or exam</td>
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inf522 - Information Processing in Bio-Medical Research

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

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

Responsible persons:
Hein, Andreas (Module responsibility)
Kaspar, Mathias (Module responsibility)
Lehrenden, Die im Modul (Authorized examiners)

Prerequisites:

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

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

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

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

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

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

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<tr>
<th>Reader's advisory</th>
<th>Wird im Modul bekannt gegeben</th>
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inf533 - Probabilistic Modelling I

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Skills to be acquired in this module

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

**Professional competence**
The students:

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

**Methodological competence**
The students:

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

**Social competence**
The students:

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

**Self-competence**
The students:

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

Module contents

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

Reader's advisory

- Recent eBooks, eTutorials

Links


Languages of instruction

- German, English

Duration (semesters)

- 1 Semester

Module frequency

- jährlich

Module capacity

- unlimited

Reference text

Associated with the module:

- inf534 Probabilistic Modelling II

Modullevel / module level

- AS (Akzentsetzung / Accentuation)

Modulart / typ of module

- je nach Studiengang Pflicht oder Wahlpflicht

Lehr-/Lernform / Teaching/Learning method

- S
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inf535 - Computational Intelligence I

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Applicability of the module
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Environmental Modelling (Master) > Mastermodule

Responsible persons
Kramer, Oliver (Authorized examiners)
Lehrenden, Die im Modul (Authorized examiners)

Prerequisites

Skills to be acquired in this module

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

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

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

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

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

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

Reader's advisory

Links
Languages of instruction: English, German
Duration (semesters): 1 Semester
Module frequency: jährlich
Module capacity: unlimited
Module level / module level: AS (Akzentsetzung / Accentuation)
Modulart / typ of module: je nach Studiengang Pflicht oder Wahlpflicht

Lehr-/Lernform / Teaching/Learning method
Vorkenntnisse / Previous knowledge: - Grundlagen der Statistik
Examination: Time of examination, Type of examination
Final exam of module: At the end of the lecture period, Written or oral exam

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Total time of attendance for the module: 56 h
### inf534 - Probabilistic Modelling II

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<td>Probabilistic models are generated with special tools (e.g. BUGS, JAGS, STAN) or domain specific programming languages (WebPPL, PyMC3, ...). If they mimic cognitive processes of humans (e.g. pilots, drivers) or animals they could be used as cooperative assistance systems in technical or financial systems like cars, robots, or recommenders. In this part of the seminar we read, present, and discuss recent research papers.</td>
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<td>Self-competence</td>
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inf536 - Computational Intelligence II

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Responsible persons

Lehrenden, Die im Modul (Authorized examiners)
Kramer, Oliver (Authorized examiners)

Prerequisites

Skills to be acquired in this module

Professional competence

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

Methodological competence

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

Social competence

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

Self-competence

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

Module contents

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

Overview of Content:

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

Reader's advisory

- HASTIE, T., TIBSHIRANI, R., FRIEDMAN, J.H.: The Elements of Statistical Learning, Springer 2009
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**inf537 - Intelligent Systems**

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**Applicability of the module**
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

**Responsible persons**
Sauer, Jürgen (Authorized examiners)
Lehrenden, Die im Modul (Authorized examiners)

**Prerequisites**

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

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

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

**Reader’s advisory**

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

**Languages of instruction**
German, English

**Duration (semesters)**
1 Semester

**Module frequency**
onece a year

**Module capacity**
unlimited

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

**Modullevel / module level**
AS (Akzentsetzung / Accentuation)

**Modulart / typ of module**
je nach Studiengang Pflicht oder Wahlpflicht

**Lehr-/Lernform / Teaching/Learning method**
V+Ü

**Vorkenntnisse / Previous knowledge**
Produktionsorientierte Wirtschaftsinformatik

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

**Course type**
Lecture
Exercises

**Comment**

**SWS**
2.00
2.00

**Frequency**
WiSe
WiSe

**Workload of compulsory attendance**
28
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**Total time of attendance for the module**
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inf551 - Maritime Systems

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**Applicability of the module**
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

**Responsible persons**
- Hahn, Axel (Authorized examiners)
- Lehrenden, Die im Modul (Authorized examiners)

**Prerequisites**

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

**Module contents**

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

**Languages of instruction**
German, English

**Duration (semesters)**
1 Semester

**Module frequency**
annually in winterterm

**Module capacity**
unlimited

**Module level / typ of module**
AS (Akzentsetzung / Accentuation)

**Lehr-/Lernform / Teaching/Learning method**
V+Ü

**Examination**
- Final exam of module at the end of the lecture period
- practical exercises and oral examination

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| Total time of attendance for the module | 56 h |

**Reader's advisory**

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

**Module frequency**
annually in winterterm

**Module capacity**
unlimited

**Module level / typ of module**
Wahlmodul / Opportunity

**Lehr-/Lernform / Teaching/Learning method**
V+Ü

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

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

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| Total time of attendance for the module | 56 h |

**Languages of instruction**
German, English

**Module frequency**
annually in winterterm

**Module capacity**
unlimited

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

**Module frequency**
annually in winterterm

**Module capacity**
unlimited

**Module level / typ of module**
Wahlmodul / Opportunity

**Lehr-/Lernform / Teaching/Learning method**
V+Ü

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

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

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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

Applicability of the module:
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Responsible persons:
Hahn, Axel (Authorized examiners)
Lehrenden, Die im Modul (Authorized examiners)

Prerequisites:

Skills to be acquired in this module:

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

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

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

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

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

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

Reader's advisory:
Suggested reading:
- Produktion und Logistik (Springer-Lehrbuch) von Hans-Otto Günther und Horst Tempelmeier von
<table>
<thead>
<tr>
<th>Links</th>
<th><a href="http://w-ol.de">http://w-ol.de</a></th>
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<tbody>
<tr>
<td>Languages of instruction</td>
<td>German, English</td>
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<tr>
<td>Duration (semesters)</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Module frequency</td>
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<tr>
<td>Module capacity</td>
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<td>Reference text</td>
<td>Dieses Modul ist im Rahmen der Projekte FiF und FoL konzipiert worden</td>
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<tr>
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<td>AS (Akzentsetzung / Accentuation)</td>
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<td>Modulart / typ of module</td>
<td>je nach Studiengang Pflicht oder Wahlpflicht</td>
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<td>Lehr-/Lernform / Teaching/Learning method</td>
<td>V+Ü</td>
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<th>Type of examination</th>
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<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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<th>Frequency</th>
<th>Workload of compulsory attendance</th>
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<tr>
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<td>28</td>
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<td>Exercises</td>
<td></td>
<td>2.00</td>
<td>SuSe</td>
<td>28</td>
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</table>

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

Module label
Application Area Maritime

Module code
inf663

Credit points
6.0 KP

Workload
180 h

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

Responsible persons
Hahn, Axel (Authorized examiners)
Lehrenden, Die im Modul (Authorized examiners)

Prerequisites

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

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

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

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

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

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

Links

Language of instruction
English

Duration (semesters)
1 Semester

Module frequency
Once a year

Module capacity
unlimited

Modullevel/module level
AS (Akzentsetzung / Accentuation)

Modulart/typ of module
Pflicht o. Wahlpflicht / compulsory or optional

Lehr-/Lernform/Teaching/Learning method
V+S

Vorkenntnisse/Previous knowledge

Examination
Time of examination
Type of examination

Final exam of module
At the end of the lecture period
Oral exam and documentation

Course type
Comment
SWS
Frequency
Workload of compulsory attendance

Lecture
2.00
SuSe and WiSe
28

Seminar
2.00
SuSe and WiSe
28

Total time of attendance for the module
56 h

123 / 198
inf974 - Human Computer Interaction and Brain Computer Interfacing

Module label: Human Computer Interaction and Brain Computer Interfacing

Module code: inf974

Credit points: 6.0 KP

Workload: 180 h

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

Responsible persons:
- Rieger, Jochem (Module responsibility)
- Lüdtke, Andreas (Module responsibility)
- Lehrenden, Die im Modul (Authorized examiners)

Prerequisites:

Skills to be acquired in this module:

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

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

Social competences:

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

Module contents:
The module consists of a lecture and an exercise part:
Lecture:
- Background and concepts of cognitive psychology relevant for human computer interaction
- Sensation, perception, action
- Data acquisition and processing methods for brain computer interfacing.

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.

Module level / module level: AS (Akzentsetzung / Accentuation)

Moduleart / typ of module: Pflicht o. Wahlpflicht / compulsory or optional

Lehr-/Lernform / Teaching/Learning method: V + TPS (Theory-Praxis-Seminar)

Vorkenntnisse / Previous knowledge:
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<th>Examination</th>
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<th>Type of examination</th>
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inf973 - Psychological practicum fNIRS, EEG

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

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

Responsible persons:
- Rieger, Jochem (Authorized examiners)
- Lehrenden, Die im Modul (Authorized examiners)

Prerequisites:

Skills to be acquired in this module:

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

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

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

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

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

Reader's advisory:

Links:

Language of instruction: English
Duration (semesters): 1 Semester
Module frequency: Once a year
Module capacity: 6

Modullevel / module level: AS (Akzentsetzung / Accentuation)
Modulart / typ of module: Pflicht / Mandatory

Lehr-/Lernform / Teaching/Learning method:

Vorkenntnisse / Previous knowledge:

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

Course type: Practical training

SWS: 4.00
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<th>Frequency</th>
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inf339 - Industrie 4.0: Digitalisierung der industriellen Produktion

Module label: Industrie 4.0: Digitalisierung der industriellen Produktion
Module code: inf339
Credit points: 6.0 KP
Workload: 180 h

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

Responsible persons

Prerequisites

Skills to be acquired in this module

Module contents

Reader's advisory

Links

Language of instruction: German
Duration (semesters): 1 Semester

Module frequency
Module capacity: unlimited

Modullevel / module level: AS (Akzentsetzung / Accentuation)
Modulart / typ of module: Wahlpflicht / Elective

Lehr-/Lernform / Teaching/Learning method

Vorkenntnisse / Previous knowledge

Examination

Time of examination
Type of examination

Final exam of module

Course type
Comment
SWS
Frequency
Workload of compulsory attendance

Lecture
2.00
SuSe or WiSe
28
Seminar
2.00
SuSe or WiSe
28

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

<table>
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<tr>
<th>Module label</th>
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<tr>
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<td>Workload</td>
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**Applicability of the module**
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction

**Responsible persons**
- Feuerstack, Sebastian (Authorized examiners)
- Lehrenden, Die im Modul (Authorized examiners)

**Prerequisites**

**Skills to be acquired in this module**

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

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

**Social competences:**
The students: --

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

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

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

The module consists of a lecture and an exercise part:

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

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

**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 Paternó)
- Introduction to ACT-R (John R. Anderson, Christian Lebiere)
- Engineering Psychology and Human Performance (Christian Wickens, Justin Hollands)
- Ecological interface design: Progress and challenges. Human Factors (Kim Vicente)
- Cognitive Work Analysis: Toward Safe, Productive, and Healthy Computer-Based Work (Kim Vicente)
- The psychology of Human Computer Interaction (Card, Moran, Newell)

<table>
<thead>
<tr>
<th>Links</th>
<th><a href="http://www.humanics.eu">http://www.humanics.eu</a></th>
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<tbody>
<tr>
<td>Language of instruction</td>
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<tr>
<td>Duration (semesters)</td>
<td>1 Semester</td>
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<td>Module capacity</td>
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<td>Reference text</td>
<td>Associated with the module(s): Application Area Automotive Usability in Medicine</td>
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<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
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<td>Lehr-/Lernform / Teaching/Learning method</td>
<td>V+Ü</td>
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<td>Examination</td>
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<td>Final exam of module</td>
<td>At the end of the lecture period</td>
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<th>SWS</th>
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<th>Workload of compulsory attendance</th>
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<td>2.00</td>
<td>SuSe and WiSe</td>
<td>28</td>
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| Total time of attendance for the module | 56 h |
inf604 - Business Intelligence I

<table>
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<tr>
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<tbody>
<tr>
<td>Module code</td>
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<td>6.0 KP</td>
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<td>Workload</td>
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Applicability of the module

- Master of Education Programme (Vocational and Business Education) Computing Science (Master of Education) > Mastermodule
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Responsible persons

Marx Gomez, Jorge (Authorized examiners)
Lehrenden, Die im Modul (Authorized examiners)

Prerequisites

Skills to be acquired in this module

Objective of the module/skills:
Current module provides basics of business intelligence with focus on enterprises and strong emphasis on data warehousing technologies. Students of the course are provided with knowledge, which reflects current research and development in a data analytic domain.

Professional competence

The students:

- name and recognize the role of business intelligence as part of daily business process
- being able to analyse advantages and disadvantages of different approaches and methods of the data analytics and being able to apply them in simple case studies
- obtain theoretical knowledge about data collection and modelling processes, including most applicable approaches and best practices

Methodological competence

The students:

- being able to execute typical tasks of business intelligence, and also being able to deepen knowledge on different approaches and methods
- gain a hands on experience and being able to understand advantages and disadvantages of different methods and being able to use obtained knowledge in most efficient ways

Social competence

The students:

- build solutions based on case studies given to the group, for example solving the issue of a factless fact table
- discuss solutions on a technical level
- present obtained case studies solutions as part of the exercises

Self-competence

The students:

- critically review provided data and information

Module contents

Data warehouse technology together with business intelligence are increasingly being used by business in order to get better decision support and enrich ongoing processes with data-rich decisions. Data warehouse technology enables an integration of data from heterogeneous sources, whether business intelligence builds data processing on top of it. For instance, business intelligence allows to build reporting on very large volumes of data (including historical) coming primary from data warehouse.

As part of the current module following contents are taught:

- Definition and scope of business intelligence.
- Procedures and objectives of data warehousing.
- Process of extracting, transforming and loading (ETL) of data.
Phases of data modelling, data capturing and reporting in conjunction with a plausible case studies/scenarios.
Prospects for further and evolving topics for business intelligence (e.g. Adaptive Business Intelligence, In-MemoryComputing, etc.)
Introduction to Data Mining.
Case studies based practical exercises and assessments in order to impart practical knowledge.

Reader's advisory

- Marx Gómez, Rautenstrauch, Ciszek (2008): Einführung in die Business Intelligence mit SAP NetWeaver 7.0.

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

Languages of instruction
German, English

Duration (semesters)
1 Semester

Module frequency
jährlich

Module capacity
unlimited

Modullevel / module level
AS (Akzentsetzung / Accentuation)

Modulart / typ of module
Wahlpflicht / Elective

Lehr-/Lernform / Teaching/Learning method
V + Ü

Vorkenntnisse / Previous knowledge

Examination
Time of examination
Type of examination
Final exam of module
At the end of the lecture period
Written exam max. 120 minutes

Course type
Comment
SWS
Frequency
Workload of compulsory attendance

Lecture
2.00
WiSe
28
Exercises
2.00
WiSe
28

Total time of attendance for the module
56 h
inf607 - Business Intelligence II

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<td>Workload</td>
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Applicability of the module
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodul der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Responsible persons
Marx Gomez, Jorge (Authorized examiners)
Lehrenden, Die im Modul (Authorized examiners)

Prerequisites

Skills to be acquired in this module
Current module provides advanced business intelligence, data science with focus on enterprises and strong emphasis on big data and data analytics. Students of the course are provided with knowledge, which reflects current research and development in a data analytics domain.

Professional competence
The students:
- name and recognize the role of data analytics / data science as part of a daily business process in a particular company
- able to organize from management perspective data analytics project
- being able to analyse advantages and disadvantages of different approaches and methods of the data analytics and being able to apply them in simple case studies
- obtain theoretical knowledge about data collection and modelling processes, including state of the art approaches and available best practices

Methodological competence
The students:
- being able to execute typical tasks of data analysis, and also being able to proceed deeper with respect to different approaches and methods
- gain a hands on experience and being able to understand advantages and disadvantages of different methods and being able to use obtained knowledge

Social competence
The students:
- build solutions based on case studies given to the group, for example design of regression model based on provided dataset
- discuss solutions on a technical level
- present obtained case studies solutions as part of the exercises

Self-competence
The students:
- critically review provided offered information

Module contents
After current course students will get advanced knowledge in the domains such as business intelligence and data analytics. Besides that, students will have a chance to have a deeper look into related technical fields such as InMemory Computing, Data Mining and Machine Learning, Big Data Processing with Distributed Systems (e.g. Apache Hadoop / Spark) from both, research and practical, perspectives. Students will be provided with real-world experience gather from business intelligence and data science related projects. Materials of the course are believed to be justified with current demands of data analytics market. Thus, providing students with relevant knowledge in order to give them advantages in future job.

Reader's advisory
- Jürgen Cleve, Uwe Lämmel (2014): "Data mining" (Deutsch)
- Max Bramer (2013): “Principles of data mining” (English)
- Ian Witten, Eibe Frank, Mark Hall (2011): “Data mining : practical machine learning tools and techniques” (English)
Jure Leskovec, Anand Rajaraman, Jeffrey Ullman (2014): "Mining of massive datasets" (English)

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<td>je nach Studiengang Pflicht oder Wahlpflicht</td>
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<td>Lehr-/Lernform / Teaching/Learning method</td>
<td>SE nach Ankündigung zu Beginn der Veranstaltung (2 SWS V + 2 SWS Ü oder Blockseminar)</td>
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### Vorkenntnisse / Previous knowledge

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<th>Type of examination</th>
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<td>At the end of the lecture period</td>
<td>Written exam (max. 120 min.)</td>
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<th>Frequency</th>
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**Total time of attendance for the module**

56 h
### mar364 - Time Series Analysis

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<td>Workload</td>
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<td>Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Human-Computer Interaction</td>
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<td>Master's Programme Environmental Modelling (Master) &gt; Mastermodule</td>
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<td>Charakteristika eines stochastischen Prozesses und deren Schätzer, Komponentenmodell, Trendbereinigung, spektrale Methoden, Filterung, lineare und nichtlineare Prozesse, Einbettungsverfahren, Kenngrößen der nichtlinearen Zeitreihenanalyse, symbolische Dynamik</td>
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<td>R. Schlittgen: Angewandte Zeitreihenanalyse mit R. Oldenbourg;</td>
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<td>R. Schlittgen &amp; B. Streilberg: Zeitreihenanalyse. Oldenbourg.;</td>
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<td>PJ Brockwell &amp; RA Davis: Time series: theory and methods. Springer;</td>
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**Total time of attendance for the module**: 56 h
### inf975 - (Neuro-)Cognitive Psychology in the wild II

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#### Responsible persons

#### Prerequisites

#### Skills to be acquired in this module

#### Module contents

#### Reader's advisory

#### Links

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#### Examination

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## inf976 - Auditory Scene Analysis in Speech and Music

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

### Responsible persons

### Prerequisites

### Skills to be acquired in this module

### Module contents

### Reader's advisory

### Links

### Language of instruction
- German

### Duration (semesters)
- 1 Semester

### Module frequency
- unlimited

### Module level / module level
- MM (Mastermodul / Master module)

### Moduleart / typ of module
- Wahlpflicht / Elective

### Lehr-/Lernform / Teaching/Learning method

### Vorkenntnisse / Previous knowledge

### Examination

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### Course type
- Seminar

### SWS
- 4.00

### Frequency
- WiSe

### Workload attendance
- 56 h
Systems Engineering

inf300 - Hybrid Systems

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

Responsible persons
- Fränzle, Martin Georg (Authorized examiners)
- Lehrenden, Die im Modul (Authorized examiners)

Prerequisites

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

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

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

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

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

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

**Reader's advisory**


**Links**

- **Languages of instruction**: English, German
- **Duration (semesters)**: 1 Semester
- **Module frequency**: once a year
- **Module capacity**: unlimited
- **Modullevel / module level**: AS (Akzentsetzung / Accentuation)
- **Modulart / typ of module**: Pflicht o. Wahlpflicht / compulsory or optional
- **Lehr-/Lernform / Teaching/Learning method**: V+Ü
- **Vorkenntnisse / Previous knowledge**: Bachelor in Computing Science oder Kenntnisse gewöhnlicher Differentialgleichungen
- **Examination**
  - **Time of examination**: At the end of the lecture period
  - **Type of examination**: Semester project including written work and final presentation

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**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

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

Responsible persons:
Mikschl, Alfred (Authorized examiners)
Lehrenden, Die im Modul (Authorized examiners)

Prerequisites:
The module provides practical relevance to the design of digital embedded systems.

Skills to be acquired in this module:

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

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

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

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

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

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

Languages of instruction:
English, German

Duration (semesters):
1 Semester

Module frequency:
semi-annual

Module capacity:
unlimited

Module level / module level:
AS (Akzentsetzung / Accentuation)

Module art / typ of module:
Pflicht o. Wahlpflicht / compulsory or optional

Lehr-/Lernform / Teaching/Learning method:
V+P

Vorkenntnisse / Previous knowledge:

Examination:
Time of examination: At the end of the lecture period
Type of examination: Portfolio (Design, development and implementation of embedded systems, colloquium)

Links:

Duration (semesters):
1 Semester

Module frequency:
semi-annual

Module capacity:
unlimited

Module level / module level:
AS (Akzentsetzung / Accentuation)

Module art / typ of module:
Pflicht o. Wahlpflicht / compulsory or optional

Lehr-/Lernform / Teaching/Learning method:
V+P

Vorkenntnisse / Previous knowledge:

Examination:
Time of examination: At the end of the lecture period
Type of examination: Portfolio (Design, development and implementation of embedded systems, colloquium)
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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

Applicability of the module:
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering
- Master's Programme Engineering Physics (Master) > Schwerpunkt: Renewable Energies

Responsible persons:
- Fatikow, Sergej (Authorized examiners)
- Lehrenden, Die im Modul (Authorized examiners)

Prerequisites:

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

Links

Languages of instruction | English, German
Duration (semesters) | 1 Semester
Module frequency | once a year
Module capacity | unlimited
Modullevel / module level | AS (Akzentsetzung / Accentuation)
Modulart / typ of module | Pflicht o. Wahlpflicht / compulsory or optional
Lehr-/Lernform / Teaching/Learning method | V+Ü
Vorkenntnisse / Previous knowledge | Regelungstechnik
Examination | Time of examination
Type of examination
Final exam of module | At the end of the lecture period until the beginning of the next semester
Hands-on-exercises and oral Exam
Course type Comment SWS Frequency Workload of compulsory attendance

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**Total time of attendance for the module**  
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### inf305 - Medical Technology

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

#### Responsible persons
- Hein, Andreas (Authorized examiners)
- Lehrenden, Die im Modul (Authorized examiners)

#### Prerequisites

#### Skills to be acquired in this module

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

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

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

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

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

#### Reader's advisory

**essential:**
- Lecture slides

**recommended:**

**secondary literature:**


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| Vorkenntnisse / Previous knowledge | - Signal und Bildverarbeitung  
- Regelungstechnik |

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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

Applicability of the module:
- Master's Programme Computing Science (Master) > Nicht Informatik
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interation
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Responsible persons:
Lehrenden, Die im Modul (Authorized examiners)
Hein, Andreas (Authorized examiners)

Prerequisites:

Skills to be acquired in this module:

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

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

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

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

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

Reader's advisory

**essential:**
lecture nodes

**recommended:**

**sekondary literature:**

Links

**Languages of instruction**
German, English

**Duration (semesters)**
1 Semester

**Module frequency**
once a year

**Module capacity**
unlimited

**Modullevel / module level**
AS (Akzentsetzung / Accentuation)

**Modulart / typ of module**
Pflicht o. Wahlpflicht / compulsory or optional

**Lehr-/Lernform / Teaching/Learning method**
V+Ü

**Vorkenntnisse / Previous knowledge**

**Examination**

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<th>Final exam of module</th>
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<td>At the end of the lecture periode</td>
<td>Portfolio: Hands-on exercises, report, and written or oral exam</td>
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**Course type**

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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

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

Responsible persons
Fatikow, Sergej (Authorized examiners)
Lehrenden, Die im Modul (Authorized examiners)

Prerequisites

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

Professional competence
The students:

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

Methodological competence
The students:

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

Social competence
The students:

- work in a team

Self-competence
The students:

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

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

Reader's advisory

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

Links
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<td>Modulart / typ of module</td>
<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
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Total time of attendance for the module 56 h
inf311 - Low Energy System Design

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

**Responsible persons**
- Lehrenden, Die im Modul (Authorized examiners)
  - Nebel, Wolfgang (Authorized examiners)

**Prerequisites**
- This module introduces the estimation of power dissipation and optimisation.

**Skills to be acquired in this module**

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

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

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

**Self-competence**
- The students:
  - Acknowledge the limits of their ability to cope with pressure during the modelling 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 FPGA – F. Kiesel, 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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<td>V+Ü</td>
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<td>- inf200 Grundlagen der Technische Informatik, - inf201 Technische Informatik, - inf203 Eingebettete Systeme I+, - inf204 Eingebettete Systeme II</td>
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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

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

Responsible persons:
Lehrenden, Die im Modul (Authorized examiners)
- Köster, Frank (Authorized examiners)

Prerequisites:

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

Professional competences:
The students:
- Discuss different levels/diverse levels sensor-technologies
- Discuss sensor-data fusion (multi-level fusion)
- Discuss Kalman-Filter
- Discuss in-vehicle data-processing
- Discuss 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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| Total time of attendance for the module                             | 56 h |


**inf334 - System Level Design**

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<tr>
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<td>Lehrenden, Die im Modul (Authorized examiners)</td>
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<tr>
<td></td>
<td>Grüttner, Kim (Authorized examiners)</td>
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<td>Prerequisites</td>
<td>Professional competences:</td>
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<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>- Ability to describe and analyze system components and architectures using system level description languages SpecC and SystemC</td>
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<tr>
<td></td>
<td>- Capabilities for partitioning and parallelizing of applications</td>
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<td>Methodological competences:</td>
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<td>The students:</td>
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<tr>
<td></td>
<td>- Knowledge of refinement and transformation techniques for transferring an initial specification into a real implementation</td>
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<tr>
<td></td>
<td>- Knowledge of the phases of a system-level design flow</td>
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<td></td>
<td>- Knowledge of current design methods and tools in system level design</td>
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<td></td>
<td>- Knowledge about formal models of computation of specification languages</td>
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<tr>
<td></td>
<td>- Knowledge of current research results and trends in system level design</td>
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<tr>
<td></td>
<td>- Capabilities for partitioning and parallelizing of applications</td>
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<td></td>
<td>- Ability to evaluate and explore design decisions</td>
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<td></td>
<td>- Ability to implement a complete system design-to-implementation specification</td>
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<tr>
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<td>Social competences:</td>
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<tr>
<td></td>
<td>The students:</td>
</tr>
<tr>
<td></td>
<td>- Implement solutions of given problems in teams</td>
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<td>- Discuss their outcomes appropriately</td>
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<td>Self-competences:</td>
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<td>The students:</td>
</tr>
<tr>
<td></td>
<td>- presentation skills</td>
</tr>
<tr>
<td></td>
<td>- reflect their solutions by using methods learned in this course</td>
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<tr>
<td>Module contents</td>
<td>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.</td>
</tr>
<tr>
<td></td>
<td>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.</td>
</tr>
</tbody>
</table>
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

Module level / module level
AS (Akzentsetzung / Accentuation)

Modulart / typ of module
Pflicht o. Wahlpflicht / compulsory or optional

Lehr-/Lernform / Teaching/Learning method
V+Ü

Previous knowledge / Vorkenntnisse

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

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

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<tr>
<td>Lehrenden, Die im Modul (Authorized examiners)</td>
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<td>Köster, Frank (Authorized examiners)</td>
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<table>
<thead>
<tr>
<th>Prerequisites</th>
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</table>

Skills to be acquired in this module

This module introduces the application area Automotive.

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

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

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

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

<table>
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<tbody>
<tr>
<td>- Core-concepts of the transportation domain</td>
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<td>- Modes of transportation (focus on the automotive sector)</td>
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<td>- Basic principles in traffic management</td>
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**inf338 - Design of Autonomous Systems**

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

**Responsible persons**
Lehrenden, Die im Modul (Authorized examiners)
Fränzle, Martin Georg (Authorized examiners)

**Prerequisites**

**Skills to be acquired in this module**

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

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

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

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

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

**Reader's advisory**

**Links**

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**Vorkenntnisse / Previous knowledge**

**Final exam of module**

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**Total time of attendance for the module**
56 h

160 / 198
inf454 - Communicating and Mobile Systems

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

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

Responsible persons:
Lehrenden, Die im Modul (Authorized examiners)
Olderog, Ernst-Rüdiger (Authorized examiners)

Prerequisites:

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

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

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

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

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

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

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

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

Reader's advisory

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

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<td>Lehrenden, Die im Modul (Authorized examiners)</td>
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<tr>
<td>Olderog, Ernst-Rüdiger (Authorized examiners)</td>
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</table>

| Prerequisites |

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

essential:


recommended:


Links

Languages of instruction: German, English
Duration (semesters): 1 Semester
Module frequency: irregular
Module capacity: unlimited
Module level / module level: AS (Akzentsetzung / Accentuation)
Modulart / typ of module: Pflicht o. Wahlpflicht / compulsory or optional
Lehr-/Lernform / Teaching/Learning method: V+Ü
Vorkenntnisse / Previous knowledge: Theoretische Informatik I + II
Examination: Time of examination, Type of examination
Final exam of module: At the end of the lecture period
Exercises and written or oral exam

Course type | Comment | SWS | Frequency | Workload of compulsory attendance | Total time of attendance for the module
--- | --- | --- | --- | --- | ---
Lecture | 3.00 | SuSe or WiSe | 42 | 56 h
Exercises | 1.00 | SuSe or WiSe | 14 | 164 / 198
inf460 - Security

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

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

Responsible persons:
Lehrenden, Die im Modul (Authorized examiners)
Fröschle, Sibylle (Authorized examiners)

Prerequisites:

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

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

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

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

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

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

Reader's advisory:

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

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

Module level / module level:
AS (Akzentsetzung / Accentuation)

Moduleart / typ of module:
Pflicht o. Wahlpflicht / compulsory or optional

Lehr-/Lernform / Teaching/Learning method:
S or V

Vorkenntnisse / Previous knowledge:
- Basic knowledge in security

Examination:
- Time of examination: will be specified in class
- Type of examination: Presentation and paper, oral exam, or exam (depending on the number of students)

Course type:
Course or seminar

SWS:
2.00
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## inf461 - Security of Cyber-Physical Systems

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

### Responsible persons
Lehrenden, Die im Modul (Authorized examiners)
- Fröschle, Sibylle (Authorized examiners)

### Prerequisites

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

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

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

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

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

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

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

### Language of instruction
English

### Duration (semesters)
1 Semester

### Module frequency
once a year

### Module capacity
unlimited

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

### Modulart / typ of module
Pflicht o. Wahlpflicht / compulsory or optional

### Lehr-/Lernform / Teaching/Learning method
S or V

### Vorkenntnisse / Previous knowledge

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### Course type
Course or seminar

### SWS
2.00

### Frequency
SuSe or WiSe

### Workload attendance
28 h
Inf502 - Simulation

Module label: Simulation
Module code: inf502
Credit points: 6.0 KP
Workload: 180 h

Applicability of the module:
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Responsible persons:
- Hahn, Axel (Module responsibility)
- Sauer, Jürgen (Module responsibility)

Prerequisites:

Skills to be acquired in this module:
Simulation is a major tool for gaining knowledge about systems and their behavior. It can be used to gain system understanding and predict future system status. The module covers mathematical basics as well as basic simulation technology. The module completes itself by addressing application examples. By seminar and practical work, the students get hands on experience of simulation technologies.

Professional competence
The students:
- get an overview on methods, tools and application areas of simulation. They know what simulation can do and what are its limitations. Covered application are mainly in transportation and production domain.

Methodological competence
The students:
- know simulation technologies and model building basics. They understand the handling of time and problems of discretization. After lecture students can solve problems with simulation. This includes modelling, use of simulation environment and evaluation of results. Cause of practical use, the independent handling of research questions and the use of simulation as research method will be learned.

Social competence
The students:
- gain team and social skills by self-organized development of simulation.

Self-competence
The students:
- can apply simulation technologies on scientific research questions.

Module contents:
In lectures the students get background information and simulation basics. Then they apply their knowledge by developing an own simulation by using state of the art simulation environments.

Reader's advisory:

Links:
Languages of instruction: German, English
Duration (semesters): 1 Semester
Module frequency: annually
Module capacity: unlimited
Modullevel / module level: AS (Akzentsetzung / Accentuation)
Modulart / typ of module: je nach Studiengang Pflicht oder Wahlpflicht
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inf522 - Information Processing in Bio-Medical Research

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<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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<tr>
<td>Professional competences</td>
<td>The students:</td>
</tr>
<tr>
<td>Know the principles of biomedical research and identify resulting requirements and develop appropriate solutions</td>
<td></td>
</tr>
<tr>
<td>Know the regulatory guidelines and assess the suitability of (IT) solutions or develop them</td>
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<tr>
<td>Plan, apply, evaluate, report and assess IT solution evaluation studies</td>
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<tr>
<td>Are aware of the biomedical research responsibility and the ethical challenges</td>
<td></td>
</tr>
<tr>
<td>Methodological competences</td>
<td>The students:</td>
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<tr>
<td>Search literature systematically</td>
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<tr>
<td>Plan and assess clinical studies</td>
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<tr>
<td>Develop concepts for a data privacy and GCP conform study management</td>
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<tr>
<td>Know and apply medical classification systems</td>
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<tr>
<td>Validate and run software for clinical trials, cohorts and registries</td>
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<tr>
<td>Plan and assess healthcare IT studies</td>
<td></td>
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<tr>
<td>Social competences</td>
<td>The students:</td>
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<tr>
<td>Present solutions/results</td>
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<tr>
<td>Discuss studies constructively, professionally and appropriately</td>
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<tr>
<td>Discuss ethical biomedical research problems from different points of view</td>
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<tr>
<td>Self-competences</td>
<td>The students:</td>
</tr>
<tr>
<td>Reflect their own values and attitudes in the context of medical and biomedical research border areas</td>
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<tr>
<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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<tr>
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<td>Biomedical research regulatory framework</td>
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<td>Biomedical research ethics</td>
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<td>IT infrastructure in research / IT components incl. molecular medicine</td>
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<tr>
<td>(Data) privacy</td>
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</table>
- 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

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<thead>
<tr>
<th>Reader's advisory</th>
<th>Wird im Modul bekannt gegeben</th>
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| Module capacity            | unlimited (                   |
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<th>Type of examination</th>
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171 / 198
## inf523 - Medical Software Engineering

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<tr>
<td>Workload</td>
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### Applicability of the module
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

### Responsible persons
- Hein, Andreas (Module responsibility)
- Kaspar, Mathias (Module responsibility)
- Klausen, Andreas (Module responsibility)
- Lehrenden, Die im Modul (Authorized examiners)
- Röhrig, Rainer (Authorized examiners)

### Prerequisites
- 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
- wird im Modul bekannt gegeben

### Links
-

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**rupted at 172 / 198**
<table>
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<tr>
<th><strong>Languages of instruction</strong></th>
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<td>V + Ü</td>
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<td>Medizin für Informatiker, Programmierkenntnisse / Softwareentwicklung / Informationssysteme / Mensch Maschine Interaktion</td>
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<tr>
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<td>At the end of the lecture periods</td>
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**Total time of attendance for the module** 56 h
### inf533 - Probabilistic Modelling I

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#### Applicability of the module
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Embedded Systems and Microrobotics (Master) > Akzentsetzungsmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

#### Responsible persons
- Möbus, Claus (Authorized examiners)
- Lehrenden, Die im Modul (Authorized examiners)

#### Prerequisites

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

**Professional competence**
The students:

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

**Methodological competence**
The students:

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

**Social competence**
The students:

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

**Self-competence**
The students:

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

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

#### Reader's advisory
Recent eBooks, eTutorials

#### Links
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 / module level
AS (Akzentsetzung / Accentuation)

#### Modulart / typ of module
je nach Studiengang Pflicht oder Wahlpflicht

#### Lehr-/Lernform / Teaching/Learning method
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### inf537 - Intelligent Systems

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<tr>
<td>Module code</td>
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<td>Credit points</td>
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<tr>
<td>Workload</td>
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</table>

#### Applicability of the module
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

#### Responsible persons
- Sauer, Jürgen (Authorized examiners)
- Lehrenden, Die im Modul (Authorized examiners)

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

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

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

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

### Links
- www.wi-ol.de

#### Languages of instruction
- German, English

#### Duration (semesters)
- 1 Semester

#### Module frequency
- once a year

#### Module capacity
- unlimited

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

#### Modul level / module level
- AS (Akzentsetzung / Accentuation)

#### Lehr-/Lernform / Teaching/Learning method
- V+Ü

#### Vorkenntnisse / Previous knowledge
- Produktionsorientierte Wirtschaftsinformatik

#### Examination
- Time of examination: At the end of the lecture period
- Type of examination: Practical exercises and oral exam or practical exercises and written exam or portfolio

<table>
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<td>Exercises</td>
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<td>WiSe</td>
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#### Total time of attendance for the module
- 56 h
inf551 - Maritime Systems

Module label: Maritime Systems
Module code: inf551
Credit points: 6.0 KP
Workload: 180 h

Applicability of the module:
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodul der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Responsible persons:
Hahn, Axel (Authorized examiners)
Lehrenden, Die im Modul (Authorized examiners)

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

Module contents:

Reader's advisory:

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

Languages of instruction:
German, English

Duration (semesters):
1 Semester

Module frequency:
annually in winterterm

Module capacity:
unlimited

Modullevel / module level:
AS (Akzentsetzung / Accentuation)

Modulart / typ of module:
Wahlmodul / Opportunity

Lehr-/Lernform / Teaching/Learning method:
V+Ü

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

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

Course type:
Comment
SWS
Frequency
Workload of compulsory attendance

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<td>WiSe</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

Applicability of the module
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodule der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

Responsible persons
Hahn, Axel (Authorized examiners)
Lehrenden, Die im Modul (Authorized examiners)

Prerequisites

Goals 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:
- Produktion und Logistik (Springer-Lehrbuch) von Hans-Otto Günther und Horst Tempelmeier von
**Links**  
http://wi-ol.de

**Languages of instruction**  
German, English

**Duration (semesters)**  
1 Semester

**Module frequency**  
jährlich

**Module capacity**  
unlimited

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

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

**Modulart / typ of module**  
je nach Studiengang Pflicht oder Wahlpflicht

**Lehr-/Lernform / Teaching/Learning method**  
V+Ü

**Vorkenntnisse / Previous knowledge**  
Produktionsorientierte Wirtschaftsinformatik

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**Total time of attendance for the module**  
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inf657 - Product Engineering

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**Applicability of the module**
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodul der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

**Responsible persons**
- Hahn, Axel (Authorized examiners)
- Lehrenden, Die im Modul (Authorized examiners)

**Prerequisites**

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

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

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

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

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

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

**Reader's advisory**
- Ehrlenspiel (2003): Integrierte Produktentwicklung

**Links**
- www.wi-ol.de
<table>
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<th>Languages of instruction</th>
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Vorkenntnisse / Previous knowledge

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<th>Type of examination</th>
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<td>Written exam or oral exam, or written documentation or Presentation or Portfolio</td>
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<table>
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<td>Exercises</td>
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<td>2.00</td>
<td>WiSe</td>
<td>28</td>
</tr>
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</table>

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

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

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

Responsible persons:
- Hahn, Axel (Authorized examiners)
- Lehrenden, Die im Modul (Authorized examiners)

Prerequisites:

Skills to be acquired in this module:

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

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

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

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

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

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

Links:

Language of instruction: English
Duration (semesters): 1 Semester
Module frequency: Once a year
Module capacity: unlimited
Modullevel / module level: AS (Akzentsetzung / Accentuation)
Modulart / typ of module: Pflicht o. Wahlpflicht / compulsory or optional
Lehr-/Lernform / Teaching/Learning method: V+S

Vorkenntnisse / Previous knowledge:

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

Course type:
- Lecture
- Seminar

Comment:

SWS:
- Lecture: 2.00
- Seminar: 2.00

Frequency:
- SuSe and WiSe

Workload of compulsory attendance:
- Lecture: 28
- Seminar: 28

Total time of attendance for the module: 56 h
inf900 - Group Project

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

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

Responsible persons:
Lehrenden, Die im Modul (Authorized examiners)

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

Skills to be acquired in this module:
The students:
- characterise and apply computer science basics (algorithms, data structures, programming, basics of practical, technical and theoretical computer science)
- define and describe essential mathematical, logical and physical basics of computer science
- define and illustrate the core disciplines of computer science (theoretical, practical and technical computer science)

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

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

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

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

Module contents:
Cooperative development of a large-scale computer science project. This project generally includes the (further) development of a hard or software system.

Reader's advisory:
According to the assigned task

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

Languages of instruction:
German, English

Duration (semesters):
2 Semester

Module frequency:
semi-annual

Module capacity:
unlimited

Reference text:
Dieses Modul ist im Rahmen der Projekte FiF und FoL konzipiert worden
<table>
<thead>
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<th><strong>Module level / module level</strong></th>
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<td>Pflicht o. Wahlpflicht / compulsory or optional</td>
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<tr>
<td><strong>Lehr-/Lernform / Teaching/Learning method</strong></td>
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</table>
| **Vorkenntnisse / Previous knowledge** | - Programmierkurs  
- Softwaretechnik  
- Soft Skills |
| **Examination** | **Time of examination** | **Type of examination** |
| **Final exam of module** | Im Stud.IP nach Bekanntgabe der einzelnen Gruppen und Themen | Active involvement, presentation, final report, project assessment |
| **Course type** | Project group |
| **SWS** | 8.00 |
| **Frequency** | SuSe and WiSe |
| **Workload attendance** | 112 h |
## inf903 - Research Project I

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<tr>
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<td>Module code</td>
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<tr>
<td>Credit points</td>
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<td>Workload</td>
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### Applicability of the module
- Master's Programme Business Informatics (Master) > Kernmodule
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

### Responsible persons
- Lehrenden, Die im Modul (Authorized examiners)
- Marx Gomez, Jorge (Module responsibility)
- Fränzle, Martin Georg (Module responsibility)

### Prerequisites


### Skills to be acquired in this module
The Module practices the scientific competencies in preparation of the master thesis. It is intended to replace the project group with the two “Research Project” modules to ensure studibility and to enable students to perform research projects at foreign universities. Additionally, it is also intended to embed the student into the research activities of the supervisor in preparation of a potential doctoral work after finishing the program.

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

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

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

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

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

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

### Links
- Languages of instruction: English, German
- Duration (semesters): 1 Semester
- Module frequency: Sommer und Winter
- Module capacity: unlimited
- Modulelevel / module level: BC (Basiscurriculum / Base curriculum)
- Modular / typ of module: je nach Studiengang Pflicht oder Wahlpflicht
- Lehr-/Lernform / Teaching/Learning method: P

### Vorkenntnisse / Previous knowledge

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<tr>
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### Course type
- Project

### SWS
- 6.00

### Frequency
- SuSe and WiSe
| Workload attendance | 84 h |
### inf339 - Industrie 4.0: Digitalisierung der industriellen Produktion

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<tr>
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<td>Credit points</td>
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#### Applicability of the module
- Master's Programme Computing Science (Master) > Technische Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

#### Responsible persons

#### Prerequisites

#### Skills to be acquired in this module

#### Module contents

#### Reader's advisory

#### Links

#### Language of instruction
German

#### Duration (semesters)
1 Semester

#### Module frequency

#### Module capacity
unlimited

#### Modullevel / module level
AS (Akzentsetzung / Accentuation)

#### Modulart / typ of module
Wahlpflicht / Elective

#### Lehr-/Lernform / Teaching/Learning method

#### Vorkenntnisse / Previous knowledge

#### Examination

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<th>Frequency</th>
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<tr>
<td>Seminar</td>
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<td>2.00</td>
<td>SuSe or WiSe</td>
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#### Total time of attendance for the module
56 h
inf604 - Business Intelligence I

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<tr>
<td>Applicability of the module</td>
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<tr>
<td></td>
<td>• Master of Education Programme (Vocational and Business Education) Computing Science (Master of Education) &gt; Mastermodule</td>
</tr>
<tr>
<td></td>
<td>• Master's Programme Business Informatics (Master) &gt; Akzentsetzungsmodule der Informatik</td>
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<td>• Master's Programme Computing Science (Master) &gt; Angewandte Informatik</td>
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<td>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Embedded Brain Computer Interaction</td>
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<tr>
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<td>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Human-Computer Interaction</td>
</tr>
<tr>
<td></td>
<td>• Master's Programme Engineering of Socio-Technical Systems (Master) &gt; Systems Engineering</td>
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</tbody>
</table>

Responsible persons
Marx Gomez, Jorge (Authorized examiners)
Lehrenden, Die im Modul (Authorized examiners)

Prerequisites

Skills to be acquired in this module
Objective of the module/skills:
Current module provides basics of business intelligence with focus on enterprises and strong emphasis on data warehousing technologies. Students of the course are provided with knowledge, which reflects current research and development in a data analytic domain.

Professional competence
The students:
• name and recognize the role of business intelligence as past of daily business process
• being able to analyse advantages and disadvantages of different approaches and methods of the data analytics and being able to apply them in simple case studies
• obtain theoretical knowledge about data collection and modelling processes, including most applicable approaches and best practices

Methodological competence
The students:
• being able to execute typical tasks of business intelligence, and also being able to deepen knowledge on different approaches and methods
• gain a hands on experience and being able to understand advantages and disadvantages of different methods and being able to use obtained knowledge in most efficient ways

Social competence
The students:
• build solutions based on case studies given to the group, for example solving the issue of a factless fact table
• discuss solutions on a technical level
• present obtained case studies solutions as part of the exercises

Self-competence
The students:
• critically review provided data and information

Module contents
Data warehouse technology together with business intelligence are increasingly being used by business in order to get better decision support and enrich ongoing processes with data-rich decisions. Data warehouse technology enables an integration of data from heterogeneous sources, whether business intelligence builds data processing on top of it. For instance, business intelligence allows to build reporting on very large volumes of data (including historical) coming primary from data warehouse.

As part of the current module following contents are taught:
• Definition and scope of business intelligence.
• Procedures and objectives of data warehousing.
• Process of extracting, transforming and loading (ETL) of data.
• Phases of data modelling, data capturing and reporting in conjunction with a plausible case studies/scenarios.
• Prospects for further and evolving topics for business intelligence (e.g. Adaptive Business Intelligence, In-Memory Computing, etc.)
• Introduction to Data Mining.
• Case studies based practical exercises and assessments in order to impart practical knowledge.

Reader's advisory

• Adamson (2010): The complete reference star schema.
• Marx Gómez, Rautenstrauch, Ciszek (2008): Einführung in die Business Intelligence mit SAP NetWeaver 7.3.
• Müller, Lenz (2013): Business Intelligence.

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

Languages of instruction
German, English

Duration (semesters)
1 Semester

Module frequency
jährlich

Module capacity
unlimited

Modullevel / module level
AS (Akzentsetzung / Accentuation)

Modulart / typ of module
Wahlpflicht / Elective

Lehr-/Lernform / Teaching/Learning method
V + Ü

Vorkenntnisse / Previous knowledge

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<th>Type of examination</th>
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<td>Written exam max. 120 minutes</td>
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Course type | Comment | SWS | Frequency | Workload of compulsory attendance |
-------------|---------|-----|-----------|----------------------------------|
| Lecture    |         | 2.00| WiSe     | 28                               |
| Exercises  |         | 2.00| WiSe     | 28                               |

Total time of attendance for the module 56 h
inf607 - Business Intelligence II

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<td>Workload</td>
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### Applicability of the module
- Master's Programme Business Informatics (Master) > Akzentsetzungsmodul der Informatik
- Master's Programme Computing Science (Master) > Angewandte Informatik
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

### Responsible persons
- Marx Gomez, Jorge (Authorized examiners)
- Lehrenden, Die im Modul (Authorized examiners)

### Prerequisites

### Skills to be acquired in this module

#### Professional competence
The students:
- name and recognize the role of data analytics / data science as part of a daily business process in a particular company
- able to organize from management perspective data analytics project
- being able to analyse advantages and disadvantages of different approaches and methods of the data analytics and being able to apply them in simple case studies
- obtain theoretical knowledge about data collection and modelling processes, including state of the art approaches and available best practices

#### Methodological competence
The students:
- being able to execute typical tasks of data analytics, and also being able to proceed deeper with respect to different approaches and methods
- gain a hands on experience and being able to understand advantages and disadvantages of different methods and being able to use obtained knowledge

#### Social competence
The students:
- build solutions based on case studies given to the group, for example design of regression model based on provided dataset
- discuss solutions on a technical level
- present obtained case studies solutions as part of the exercises

#### Self-competence
The students:
- critically review provided offered information

### Module contents
After current course students will get advanced knowledge in the domains such as business intelligence and data analytics. Besides that, students will have a chance to have a deeper look into related technical fields such as InMemory Computing, Data Mining and Machine Learning, Big Data Processing with Distributed Systems (e.g. Apache Hadoop / Spark) from both, research and practical perspectives. Students will be provided with real-world experience gather from business intelligence and data science related projects. Materials of the course are believed to be justified with current demands of data analytics market. Thus, providing students with relevant knowledge in order to give them advantages in future job.

### Reader's advisory
- Jürgen Cleve, Uwe Lämmel (2014): "Data mining" (Deutsch)
- Max Bramer (2013): "Principles of data mining" (English)
- Ian Witten, Eibe Frank, Mark Hall (2011): "Data mining : practical machine learning tools and techniques" (English)
• Jure Leskovec, Anand Rajaraman, Jeffrey Ullman (2014): “Mining of massive datasets” (English)

<table>
<thead>
<tr>
<th>Links</th>
<th><a href="http://www.wi-ol.de/">http://www.wi-ol.de/</a></th>
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</thead>
<tbody>
<tr>
<td>Languages of instruction</td>
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<tr>
<td>Duration (semesters)</td>
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<td>Module frequency</td>
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<td>Module capacity</td>
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<td>Module level / module level</td>
<td>AS (Akzentsetzung / Accentuation)</td>
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<tr>
<td>Module type / typ of module</td>
<td>je nach Studiengang Pflicht oder Wahlpflicht</td>
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<tr>
<td>Teaching/Learning method</td>
<td>SE nach Ankündigung zu Beginn der Veranstaltung (2 SWS V + 2 SWS Ü oder Blockseminar)</td>
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| Vorkenntnisse / Previous knowledge |
|---|---|---|
| Examination | Time of examination | Type of examination |
| Final exam of module | At the end of the lecture period | Written exam (max. 120 min.) |

<table>
<thead>
<tr>
<th>Course type</th>
<th>Comment</th>
<th>SWS</th>
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<th>Workload of compulsory attendance</th>
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<td>Lecture</td>
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<tr>
<td>Seminar</td>
<td>2.00</td>
<td>SuSe</td>
<td>28</td>
<td></td>
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</tbody>
</table>

| Total time of attendance for the module | 56 h |
mar364 - Time Series Analysis

Module label: Time Series Analysis
Module code: mar364
Credit points: 6.0 KP
Workload: 180 h
(Präsenzzeit: 56 Stunden, Selbststudium: 124 Stunden)

Applicability of the module:
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering
- Master's Programme Environmental Modelling (Master) > Mastermodule
- Master's Programme Marine Environmental Sciences (Master) > Mastermodule
- Master's Programme Marine Sensors (Master) > Mastermodule

Responsible persons:
Freund, Jan (Authorized examiners)

Prerequisites:
Keine

Skills to be acquired in this module:
VL/Ü Zeitreihenanalyse

Die Studenten besitzen die Fähigkeit Zeitreihen zu visualisieren und mit Standardmethoden der Zeitreihenanalyse zu analysieren. Sie können Zeitreihen als im Meßprozeß verrauschte Realisierungen unterliegender stochastischer Prozesse auffassen und sind in der Lage, Schätzer mit ihren wesentlichen Merkmalen (Verzerrung, Konsistenz und Effizienz, Verteilung) sicher zu handhaben und die Resultate zuverlässig zu interpretieren.

Sie können reale Zeitreihen im Kontext wissenschaftlicher Qualitätsanforderungen bewerten, transformieren/bereinigen/modifizieren und analysieren bzw. für anschließende Analysen aufbereiten.

Module contents:

VL Zeitreihenanalyse
Charakteristika eines stochastischen Prozesses und deren Schätzer, Komponentenmodell, Trendbereinigung, spektrale Methoden, Filterung, lineare und nichtlineare Prozesse, Einbettungsverfahren, Kenngrößen der nichtlinearen Zeitreihenanalyse, symbolische Dynamik

Ü Zeitreihenanalyse
Vertiefung der Inhalte der zugehörigen VL sowie praktische Übungen

Reader's advisory:
R. Schlittgen: Angewandte Zeitreihenanalyse mit R. Oldenbourg;
R. Schlittgen & B. Streiberg: Zeitreihenanalyse. Oldenbourg;
PJ Brockwell & RA Davis: Time series : theory and methods, Springer;

Links:
Languages of instruction: German, English
Duration (semesters): 1 Semester
Module frequency:
Module capacity: unlimited
Modullevel / module level: MM (Mastermodul / Master module)
Modulart / typ of module: Wahlpflicht / Elective
Lehr-/Lenform / Teaching/Learning method:
Sommersemester:
VL Zeitreihenanalyse (2 SWS, 3 KP)
Ü Zeitreihenanalyse (2 SWS, 3 KP)
<table>
<thead>
<tr>
<th>Vorkenntnisse / Previous knowledge</th>
<th>Erfahrung im Umgang mit R oder Matlab.</th>
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<tbody>
<tr>
<td>Examination</td>
<td>Time of examination</td>
</tr>
<tr>
<td>Final exam of module</td>
<td>Klausur am Ende der Veranstaltungszeit oder fachpraktische Übungen oder mündliche Prüfung oder Portfolio nach Maßgabe der Dozentin oder des Dozenten</td>
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<tr>
<td>Type of examination</td>
<td>KL</td>
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<tr>
<td>Course type</td>
<td>Comment</td>
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<tr>
<td>Lecture</td>
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<td>Exercises</td>
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<tr>
<td>Total time of attendance for the module</td>
<td>56 h</td>
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**inf975 - (Neuro-)Cognitive Psychology in the wild II**

<table>
<thead>
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**Applicability of the module**
- Master's Programme Engineering of Socio-Technical Systems (Master) > Embedded Brain Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Human-Computer Interaction
- Master's Programme Engineering of Socio-Technical Systems (Master) > Systems Engineering

**Responsible persons**

**Prerequisites**

**Skills to be acquired in this module**

**Module contents**

**Reader's advisory**

**Links**
- Language of instruction: German
- Duration (semesters): 1 Semester
- Module frequency: unlimited
- Module level / module level: MM (Mastermodul / Master module)
- Modulart / typ of module: Wahlpflicht / Elective

**Lehr-/Lernform / Teaching/Learning method**

**Vorkenntnisse / Previous knowledge**

**Examination**
- Time of examination: Final exam of module
- Type of examination: KL

**Course type**
- Seminar

**SWS**
- 4.00

**Frequency**
- WiSe

**Workload attendance**
- 56 h
Abschlussmodul

mam - Master’s Thesis Module

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**Applicability of the module**
- Master’s Programme Engineering of Socio-Technical Systems (Master) > Abschlussmodul

**Responsible persons**
- der Informatik, Lehrende (Authorized examiners)

**Prerequisites**

**Skills to be acquired in this module**

The students prove that they are able to process and solve complex computer science tasks based on gained scientific knowledge and applied research methods. The students successfully implement a task especially by using their acquired professional and methodological knowledge and their professional and social competences.

The accompanying seminar is used to discuss the master’s thesis methodically and content-related. During the seminar the exchange of research and practical experience fosters the students’ ability to discuss and evaluate their thesis with other students and experts. The master’s thesis is finished by a colloquium.

**Social competences:**
- The students:
  - Recognise and evaluate applied techniques and methods of their subject and are aware of their limits
  - Design solutions for complex, possibly vaguely defined or unusual computer science tasks/problems and evaluate these with reference to state of the art computer science and technology
  - Identify, structure and solve problems/tasks, also in new or developing subject areas
  - Apply state of the art and innovative methods to solve problems, if necessary from other disciplines
  - Relate knowledge from different disciplines and apply this new knowledge in complex situations
  - Develop complex computer systems, processes and datamodels
  - Are aware of the current limits and contribute to the development of computer science research and technology
  - Discuss and evaluate recent computer science developments

**Professional competences:**
- The students:
  - Identify and develop one or more solutions
  - Evaluate and apply tools, technology and methods sophisticatedly
  - Examine tasks with technical and research literature, write an academic article and present their solutions academically
  - Schedule processes and resources
  - Apply project management techniques
  - Combine new and original approaches and methods creatively
  - Evaluate problems/tasks, including new or developing subject areas of their discipline and apply computer science methods for solutions and research

**Methodological competences:**
- The students:
  - Communicate with users and experts convincingly
  - Take reasonable decisions

**Social competences:**
- The students:
  - Communicate with users and experts convincingly
  - Take reasonable decisions

**Self-competences:**
- The students:
  - Pursue the overall and special computer science development critically
  - Implement innovative professional activities effectively and independently
  - Recognise their abilities and extend them purposefully
  - Reflect their self-perception and actions with regard to professional, methodological and social aspects
  - Develop and reflect self-developed hypothesis to theories independently
  - Work in their field independently
<table>
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<th>Module contents</th>
<th>The content of this module is an independent topic research. The research findings will be presented and discussed in a master's thesis colloquium.</th>
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