Module Catalogue
for the Subject
Computer Science
as a Master’s with 1 major
with the degree "Master of Science"
(120 ECTS credits)

Examination regulations version: 2018
Responsible: Faculty of Mathematics and Computer Science
Responsible: Institute of Computer Science
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Content and Objectives of the Programme

The objective of the Master of Computer Science degree program is to impart in-depth knowledge of scientific research, fields of application and principles in computer science, in particular with regard to algorithmic thinking and mathematical reasoning.

Based on the foundation that the student has acquired in a bachelor's degree program, these abilities permit him/her to work independently, broaden and deepen his/her area of expertise, and transfer his/her expertise to new tasks. The student will thus be prepared to face the diverse tasks that he/she will be confronted with by society. The student will further prove his/her methodological competence, creativity and flexibility by solving problems using methods in computer science. A degree in this course of studies allows the student to pursue a scientific career, for example, at a doctoral level.

The master's program focuses on enhancing the capacity for abstraction, for precise analytical thinking, for the ability to structure complex connections, and for an independent application of methods in computer science to address specific problems, for perseverance in solving difficult problems and for qualified scientific research. The student demonstrates these abilities in the master's exam. Passing the exam, the student is awarded a higher professional degree. With his/her master's thesis, the student demonstrates his/her ability to work independently on a restricted computer science problem by applying established or adapted methods in accordance with scientific standards.

In particular, students of the master's program in Computer Science have the possibility of specialising in one of the following areas:

Algorithms and Theory,
Software Engineering,
Internet Technology,
Intelligent Systems,
Embedded Systems,
Aerospace Engineering, Astronautics and Space Technology and
Human-Computer-Interaction.

By focusing on one of these areas, the student augments his/her expertise in the respective area.
Abbreviations used

Course types: E = field trip, K = colloquium, O = conversatorium, P = placement/lab course, R = project, S = seminar, T = tutorial, Ü = exercise, V = lecture

Term: SS = summer semester, WS = winter semester

Methods of grading: NUM = numerical grade, B/NB = (not) successfully completed

Regulations: (L)ASPO = general academic and examination regulations (for teaching-degree programmes), FSB = subject-specific provisions, SFB = list of modules

Other: A = thesis, LV = course(s), PL = assessment(s), TN = participants, VL = prerequisite(s)

Conventions

Unless otherwise stated, courses and assessments will be held in German, assessments will be offered every semester and modules are not creditable for bonus.

Notes

Should there be the option to choose between several methods of assessment, the lecturer will agree with the module coordinator on the method of assessment to be used in the current semester by two weeks after the start of the course at the latest and will communicate this in the customary manner.

Should the module comprise more than one graded assessment, all assessments will be equally weighted, unless otherwise stated below.

Should the assessment comprise several individual assessments, successful completion of the module will require successful completion of all individual assessments.

In accordance with

the general regulations governing the degree subject described in this module catalogue:

ASPO2015

associated official publications (FSB (subject-specific provisions)/SFB (list of modules)):


This module handbook seeks to render, as accurately as possible, the data that is of statutory relevance according to the examination regulations of the degree subject. However, only the FSB (subject-specific provisions) and SFB (list of modules) in their officially published versions shall be legally binding. In the case of doubt, the provisions on, in particular, module assessments specified in the FSB/SFB shall prevail.
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### Contents

Independent review of a current topic in computer science based on literature and, where applicable, software with written and oral presentation.

### Intended learning outcomes

The students are able to independently review a current topic in computer science, to summarise the main aspects in written form and to orally present these in an appropriate way.

### Courses

(type, number of weekly contact hours, language — if other than German)

S (2)

### Method of assessment

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

term paper (10 to 15 pages) and presentation (30 to 45 minutes) with subsequent discussion on a topic from the field of computer science

Language of assessment: German and/or English

### Allocation of places

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### Additional information

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): AT, SE, IT, IS, ES, LR, HCI.

### Referred to in LPO I

(examination regulations for teaching-degree programmes)

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### Contents

Independent review of a current topic in computer science based on literature and, where applicable, software with written and oral presentation.

### Intended learning outcomes

The students are able to independently review a current topic in computer science, to summarise the main aspects in written form and to orally present these in an appropriate way.

### Courses (type, number of weekly contact hours, language — if other than German)

| S (2) |

### Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Term paper (10 to 15 pages) and presentation (30 to 45 minutes) with subsequent discussion on the topic of the seminar.

Language of assessment: German and/or English.

### Allocation of places

--

### Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits):

AT, SE, IT, IS, ES, LR, HCI, GE

### Referred to in LPO I (examination regulations for teaching-degree programmes)

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**Contents**

Completion of a practical task.

**Intended learning outcomes**

The practical allows participants to work on a problem in computer science in teams.

**Courses** (type, number of weekly contact hours, language — if other than German)

P (6)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

term paper (5 to 15 pages)

Language of assessment: German and/or English

**Allocation of places**

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**Additional information**

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits):

AT, SE, IT, IS, ES, LR, HCI, GE

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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Compulsory Electives
(70 ECTS credits)
General Compulsory Electives
(min. 50 ECTS credits)
### Module title
3D Point Cloud Processing

### Abbreviation
10-I=3D-161-m01

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### Contents
Laser scanning, Kinect and camera models, basic data structures (lists, arrays, oct-trees), calculating normals, k-d trees, registration, features, segmentation, tracking, applications for airborne mapping, applications to mobile mapping.

### Intended learning outcomes
Students understand the fundamental principles of all aspects of 3D point cloud processing and are able to communicate with engineers / surveyors / CV people / etc. Students are able to solve problems of modern sensor data processing and have experienced that real application scenarios are challenging in terms of computational requirements, in terms of memory requirements and in terms of implementation issues.

### Courses
(type, number of weekly contact hours, language — if other than German)

- V (2) + Ü (2)
- Module taught in: English

### Method of assessment
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

- written examination (approx. 60 to 120 minutes).
  - If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
  - Separate written examination for Master’s students.
  - Language of assessment: German and/or English creditable for bonus

### Allocation of places
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### Additional information
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits):
IS,LR,HCI,GE

### Referred to in LPO I
(examination regulations for teaching-degree programmes)
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<tr>
<td>holder of the Chair of Computer Science II</td>
<td>Institute of Computer Science</td>
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**Contents**

Batch, time sharing, real-time virtual machines, system calls, processes and threads, cooperating processes, schedulers, process synchronisation, semaphores, monitors, critical regions, deadlocks, dynamic memory management, segmentation, paging, file systems, interfaces, directory structure, network file systems, hard drive organisation, basics of MS operating systems.

**Intended learning outcomes**

The students possess knowledge and practical skills in building and using essential parts of operating systems.

**Courses** (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — If not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).

If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Separate written examination for Master's students.

Language of assessment: German and/or English creditable for bonus

**Allocation of places**

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**Additional information**

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits):

SE,ES,GE

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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### Contents

Foundations in the following areas: definition of data mining and knowledge discovery in databases, process model, relationship to data warehouse and OLAP data preprocessing, data visualisation, unsupervised learning methods (cluster- and association methods), supervised learning (e.g. Bayes classification, KNN, decision trees, SVM), learning methods for special data types, further learning paradigms.

### Intended learning outcomes

The students possess a theoretical and practical knowledge of typical methods and algorithms in the area of data mining and machine learning. They are able to solve practical knowledge discovery problems with the help of the knowledge acquired in this course and by using the KDD process. They have acquired experience in the use or implementation of data mining algorithms.

### Courses

(type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

### Method of assessment

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).

If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Separate written examination for Master’s students.

Language of assessment: German and/or English creditable for bonus

### Allocation of places

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### Additional information

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): IT, IS, HCI, GE.

Referred to in LPO I (examination regulations for teaching-degree programmes)

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**Contents**

Relational algebra and complex SQL statements; database planning and normal forms, XML data modelling; transaction management.

**Intended learning outcomes**

The students possess knowledge about data modelling and queries in SQL, transactions as well as about easy data modelling in XML.

**Courses**

(type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

**Method of assessment**

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).

If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Separate written examination for Master’s students.

Language of assessment: German and/or English creditable for bonus

**Allocation of places**

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**Additional information**

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): SE, IS, HCI, GE.

**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

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**Contents**

Data warehouses and data mining; web databases; introduction to Datalog.

**Intended learning outcomes**

The students have advanced knowledge about relational databases, XML and data mining.

**Courses** (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English

**Allocation of places**

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**Additional information**

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): SE, IS, HCI.

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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## Module title
Interactive Computer Graphics

## Abbreviation
10-I=ICG-161-m01

## Module coordinator
holder of the Chair of Computer Science IX

## Module offered by
Institute of Computer Science

## ECTS
5

## Method of grading
numerical grade

## Only after succ. compl. of module(s)
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## Duration
1 semester

## Module level
graduate

## Other prerequisites
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### Contents
Computer graphics studies methods for digitally synthesising and manipulating visual content. This course specifically concentrates on interactive graphics with an additional focus on 3D graphics as a requirement for many contemporary as well as for novel human-computer interfaces and computer games. The course will cover topics about light and images, lighting models, data representations, mathematical formulations of movements, projection as well as texturing methods. Theoretical aspects of the steps involved in ray-tracing and the raster pipeline will be complemented by algorithmical approaches for interactive image syntheses using computer systems. Accompanying software solutions will utilise modern graphics packages and languages like OpenGL, GLSL and/or DirectX.

### Intended learning outcomes
At the end of the course, the students will have a broad understanding of the underlying theoretical models of computer graphics. They will be able to implement a prominent variety of these models, to build their own interactive graphics applications and to choose the right software tool for this task.

### Courses
(V (2) + Ü (2))

### Method of assessment
written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Separate written examination for Master’s students.
Language of assessment: German and/or English

### Allocation of places
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### Additional information
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): HCI.

Refered to in LPO I
(examination regulations for teaching-degree programmes)

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<table>
<thead>
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<tr>
<td>Computational Complexity</td>
<td>10-I=KT-161-m01</td>
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**Contents**

Complexity measurements and classes, general relationships between space and time classes, memory consumption versus computation time, determinism versus indeterminism, hierarchical theorems, translation methods, P-NP problem, completeness problems, Turing reduction, interactive proof systems.

**Intended learning outcomes**

The students possess a fundamental and applicable knowledge in the areas of complexity measurements and classes, general relationships between space and time classes, memory consumption versus computation time, determinism versus indeterminism, hierarchical theorems, translation methods, P-NP problem, completeness problems, Turing reduction, interactive proof systems.

**Courses** (type, number of weekly contact hours, language — if other than German)

| V (2) + Ü (2) |

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).

If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Separate written examination for Master’s students.

Language of assessment: German and/or English creditable for bonus

**Allocation of places**

--

**Additional information**

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): AL, IT, IS, ES, GE.

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

--
## Module title
Cryptography and Data Security

### Abbreviation
10-I=KD-161-m01

### Module coordinator
Dean of Studies Informatik (Computer Science)

### Module offered by
Institute of Computer Science

### ECTS
5

### Method of grading
Numerical grade

### Only after succ. compl. of module(s)
--

### Duration
1 semester

### Module level
Graduate

### Other prerequisites
--

### Contents
- Private key cryptography systems, Vernam one-time pad, AES, perfect security, public key cryptography systems, RSA, Diffie-Hellman, Elgamal, Goldwasser-Micali, digital signature, challenge-response methods, secret sharing, millionaire problem, secure circuit evaluation, homomorphous encryption.

### Intended learning outcomes
The students possess a fundamental and applicable knowledge in the areas of private key cryptography systems, Vernam one-time pad, AES, perfect security, public key cryptography, RSA, Diffie-Hellman, Elgamal, Goldwasser-Micali, digital signature, challenge-response method, secret sharing, millionaire problem, secure circuit evaluation, homomorphous encryption.

### Courses
- **V (2) + Ü (2)**

### Method of assessment
- Written examination (approx. 60 to 120 minutes).
- If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
- Separate written examination for Master’s students.
- Language of assessment: German and/or English

### Allocation of places
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### Additional information
- Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): AL, SE, IT, IS, GE.
- Referred to in LPO I (examination regulations for teaching-degree programmes)
### Module title

**Advanced Programming**

| Abbreviation | 10-I=APR-161-m01 |

### Module coordinator

holder of the Chair of Computer Science II

### Module offered by

Institute of Computer Science

### ECTS

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<td>1 semester</td>
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### Contents

With the knowledge of basic programming, taught in introductory lectures, it is possible to realize simpler programs. If more complex problems are to be tackled, suboptimal results like long, incomprehensible functions and code duplicates occur. In this lecture, further knowledge is to be conveyed on how to give programs and code a sensible structure. Also, further topics in the areas of software security and parallel programming are discussed.

### Intended learning outcomes

Students learn advanced programming paradigms especially suited for space applications. Different patterns are then implemented in multiple languages and their efficiency measured using standard metrics. In addition, parallel processing concepts are introduced culminating in the use of GPU architectures for extremely quick processing.

### Courses

(type, number of weekly contact hours, language — if other than German)

| V (2) + Ü (2) |

### Method of assessment

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).

If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Language of assessment: German and/or English creditable for bonus

### Allocation of places

--

### Additional information

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits):

SE, IS, LR, HCI, ES, GE

Referred to in LPO I (examination regulations for teaching-degree programmes)

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<td>Security of Software Systems</td>
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## Contents
The lecture provides an overview of common software vulnerabilities, state-of-the-art attack techniques on modern computer systems, as well as the measures implemented to protect against these attacks. In the course, the following topics are discussed:
- x86-64 instruction set architecture and assembly language
- Runtime attacks (code injection, code reuse, defenses)
- Web security
- Blockchains and smart contracts
- Side-channel attacks
- Hardware security

## Intended learning outcomes
Students gain a deep understanding of software security, from hardware and low-level attacks to modern concepts such as blockchains. The lecture prepares for research in the area of security and privacy, while the exercises allow students to gain hands-on experience with attacks and analysis of systems from an attacker’s perspective.

## Courses
(type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)
Module taught in: English

## Method of assessment
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: English
creditable for bonus

## Allocation of places
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## Additional information
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): SE, IS, LR, HCI, ES.
Basic programming knowledge in C is required.

## Referred to in LPO I
(examination regulations for teaching-degree programmes)
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**Module coordinator**

holder of the Chair of Computer Science V  
Institute of Computer Science

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</table>

**Contents**

Instruction set architectures, command processing through pipelining, statical and dynamic instruction scheduling, caches, vector processors, multi-core processors.

**Intended learning outcomes**

The students master the most important techniques to design fast computers as well as their interaction with compilers and operating systems.

**Courses** (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).  
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).  
Separate written examination for Master’s students.  
Language of assessment: German and/or English creditable for bonus

**Allocation of places**

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**Additional information**

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): SE, IT, ES, LR, GE.

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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<td>1 semester</td>
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**Contents**


**Intended learning outcomes**

The students possess an intricate knowledge of the structure of computer networks and communication systems as well as fundamental principles to rate these systems.

**Courses** (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).

If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Separate written examination for Master’s students.

Language of assessment: German and/or English creditable for bonus

**Allocation of places**

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**Additional information**

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): IT, ES, LR.

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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<td>1 semester</td>
<td>graduate</td>
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## Contents

Foundations in the following areas: knowledge management systems, knowledge representation, solving methods, knowledge acquisition, learning, guidance dialogue, semantic web.

## Intended learning outcomes

The students possess theoretical and practical knowledge for the understanding and design of knowledge-based systems including knowledge formalisation and have acquired experience in a small project.

## Courses

V (2) + Ü (2)

## Method of assessment

Written examination (approx. 60 to 120 minutes). If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate). Separate written examination for Master's students. Language of assessment: German and/or English creditable for bonus.

## Allocation of places

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## Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): SE, IT, IS, HCI, GE.

## Referred to in LPO I

(Examination regulations for teaching-degree programmes)

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### Module title
Project - Current Topics in Computer Science

### Abbreviation
10-I=PRJAK-162-m01

### Module coordinator
Dean of Studies Informatik (Computer Science)

### Module offered by
Institute of Computer Science

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### Duration
1 semester

### Module level
graduate

### Other prerequisites
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### Contents
Completion of a project task (in Teams).

### Intended learning outcomes
The project allows participants to work on a problem in computer science in teams.

### Courses (type, number of weekly contact hours, language — if other than German)
P (4)

### Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

- project report (10 to 15 pages) and presentation of project (15 to 30 minutes)

Each project is offered one time only. The project will not be repeated; there will not be another project with the same topic. Assessment can, therefore, only be offered for the project offered in the respective semester. Assessment offered: In the semester in which the course is offered

Language of assessment: German and/or English

### Allocation of places
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### Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): AT, SE, IT, IS, ES, LR, HCI, GE.

### Referred to in LPO I (examination regulations for teaching-degree programmes)
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<td>Advanced Automation</td>
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**Module coordinator**
holder of the Chair of Computer Science VII  
Institute of Computer Science

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<td>1 semester</td>
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</table>

**Contents**
Advanced topics in automation systems as well as instrumentation and control engineering, for example from the field of sensor data processing, actuators, cooperating systems, mission and trajectory planning.

**Intended learning outcomes**
The students have an advanced knowledge of selected topics in automation systems. They are able to implement advanced automation systems.

**Courses**
(V (4) + Ü (2))

**Method of assessment**
written examination (approx. 60 to 120 minutes)  
creditable for bonus

**Allocation of places**
--

**Additional information**
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits):  
IT, IS, ES, LR, GE

**Referred to in LPO I** (examination regulations for teaching-degree programmes)
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## Module title

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<th>Algorithms for Geographic Information Systems</th>
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### Abbreviation

10-I=AGIS-161-m01

### Module coordinator

holder of the Chair of Computer Science I

## Module offered by

Institute of Computer Science

## ECTS

5

## Method of grading

Only after succ. compl. of module(s)

## Numerical grade

--

## Duration

1 semester

## Module level

graduate

## Other prerequisites

--

### Contents

Algorithmic foundations of geographic information systems and their application in selected problems of acquisition, processing, analysis and presentation of spatial information. Processes of discrete and continuous optimisation. Applications such as the creation of digital height models, working with GPS trajectories, tasks of spatial planning as well as cartographic generalisation.

### Intended learning outcomes

The students are able to formalise algorithmic problems in the field of geographic information systems as well as to select and improve suitable approaches to solving these problems.

### Courses

V (2) + Ü (2)

### Method of assessment

written examination (approx. 60 to 120 minutes).

If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Language of assessment: German and/or English creditable for bonus

### Allocation of places

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### Additional information

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits):

AT, IS, HCI

### Referred to in LPO I

(examination regulations for teaching-degree programmes)

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<td>Computational Geometry</td>
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**Module coordinator**

holder of the Chair of Computer Science I

**Module offered by**

Institute of Computer Science

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**Duration**

1 semester

**Module level**

graduate

**Other prerequisites**

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**Contents**

In many areas of computer science -- for example robotics, computer graphics, virtual reality and geographic information systems -- it is necessary to store, analyse, create or manipulate spatial data. This class is about the algorithmic aspects of these tasks: We will acquire techniques that are needed to plan and analyse geometric algorithms and data structures. Every technique will be illustrated with a problem in the practical areas listed above.

**Intended learning outcomes**

The students are able to decide which algorithms or data structures are suitable for the solution of a given geometric problem. The students are able to analyse new problems and to come up with their own efficient solutions based on the concepts and techniques acquired in the lecture.

**Courses**

(type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

**Method of assessment**

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English creditable for bonus

**Allocation of places**

--

**Additional information**

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits):

AT, HCI, GE

**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

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Module title: Approximation Algorithms
Abbreviation: 10-I=APA-161-m01

Module coordinator: holder of the Chair of Computer Science I
Module offered by: Institute of Computer Science

ECTS: 5
Method of grading: Only after succ. compl. of module(s)
numerical grade: --
Duration: 1 semester
Module level: graduate
Other prerequisites: --

Contents:
The task of finding the optimal solution for a given problem is omnipresent in computer science. Unfortunately, there are many problems without an efficient algorithm for an optimal solution. As a result, in practice, methods are used which do not always give the optimal solution but always give good solutions. This lecture will discuss drafting and analysing techniques for algorithms which have a proven approximation quality. With the help of practical optimisation problems, the lecture will introduce students to important drafting techniques such as greedy, local search, scaling as well as methods based on linear programming.

Intended learning outcomes:
The students are able to analyse easy approximation methods in terms of their quality. They understand fundamental drafting techniques such as greedy, local search and scaling as well as methods based on linear programming and are able to apply these to new problems.

Courses:
(type, number of weekly contact hours, language — if other than German)
V (2) + Ü (2)

Method of assessment:
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English creditable for bonus

Allocation of places:
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Additional information:
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits):
AT, IT, GE

Referred to in LPO I (examination regulations for teaching-degree programmes):
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Module title | Automata Theory
---|---
Abbreviation | 10-I=AUT-161-m01

Module coordinator | Dean of Studies Informatik (Computer Science)
Module offered by | Institute of Computer Science
ECTS | 5
Method of grading | numerical grade
Only after succ. compl. of module(s) | --
Duration | 1 semester
Module level | graduate
Other prerequisites | --

Contents
Finite automata, regular languages, star-free languages, natural equivalence relations, predicate logic with words, language acceptance through monoids, syntactic monoid, predicate logical and algebraic characterisation of regular languages and star-free languages, two-way automata.

Intended learning outcomes
The students possess a fundamental and applicable knowledge in the areas of finite automata, regular languages, star-free languages, natural equivalence relations, predicate logic with words, language acceptance through monoids, syntactic monoid, predicate logical and algebraic characterisation of regular and star-free languages, two-way automata.

Courses (type, number of weekly contact hours, language — if other than German)
V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English creditable for bonus

Allocation of places
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Additional information
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): AT, IT, ES, HCI, GE

Referred to in LPO I (examination regulations for teaching-degree programmes)
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<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>Avionics Systems</td>
<td>10-I=AVS-161-m01</td>
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**Module coordinator**
holder of the Chair of Computer Science VIII

**Module offered by**
Institute of Computer Science

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**Duration**
1 semester

**Module level**
graduate

**Contents**
The course *Avionik-Systeme (Avionics Systems)* offers an overview of software, hardware, sensors, actuators and communication of airplanes and satellites: 1. software module and the software structure 2. control 3. ground control, 4. sensors and actuators, 5. sensor fusion, 6. reliability

**Intended learning outcomes**
At the end of the course, the students should be familiar with typical structures of avionic systems for satellites and airplanes. They should be able to design these. They should be able to program simple controls.

**Courses**
(type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

**Method of assessment**
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).

If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Language of assessment: German and/or English creditable for bonus

**Allocation of places**
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**Additional information**
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): ES, LR

**Referred to in LPO I**
(examination regulations for teaching-degree programmes)

--
### Module title
Multimodal User Interfaces

### Abbreviation
10-HCI-MMUI-161-m01

### Module coordinator
holder of the Chair of Computer Science IX

### Module offered by
Institute of Computer Science

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</table>

### Duration
1 semester

### Module level
graduate

### Other prerequisites
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### Contents
The multimodal interaction paradigm simultaneously uses various modalities like speech, gesture, touch, or gaze, to communicate with computers and machines. Basically, multimodal interaction includes the analysis as well as the synthesis of multimodal utterances. This course concentrates on the analysis, i.e., the input processing. Input processing has the goal to derive meaning from signal to provide a computerized description and understanding of the input and to execute the desired interaction. In multimodal systems, this process is interleaved between various modalities and multiple interdependencies exist between simultaneous utterances necessary to take into account for a successful machine interpretation.

In this course, students will learn about the necessary steps involved in processing unimodal as well as multimodal input. The course will highlight typical stages in multimodal processing. Using speech processing as a primary example, they learn about:
1. A/D conversion
2. Segmentation
3. Syntactical analysis
4. Semantic analysis
5. Pragmatic analysis
6. Discourse analysis

A specific emphasize will be on stages like morphology and semantic analysis. Typical aspects of multimodal interdependencies, i.e., temporal and semantic interrelations are highlighted and consequences for an algorithmic processing are derived. Prominent multimodal integration (aka multimodal fusion) approaches are described, including transducers, state machines, and unification.

### Intended learning outcomes
After the course, the students will be able to build their own multimodal interfaces. They will have a broad understanding of all the necessary steps involved and will know prominent algorithmic solutions for each of them. Student will learn about available tools for reoccurring tasks and their pros and cons.

### Courses
(V (2) + Ü (2))

<table>
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<td>presentation of project results (approx. 40 minutes)</td>
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### Allocation of places
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### Additional information
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### Referred to in LPO I
(examination regulations for teaching-degree programmes)

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</table>

**Contents**

- Gödel numbering, computable functions, decidable and countable sets, halting problem, m-reducibility, creative and productive sets, relative computability, Turing reduction, countable degrees, arithmetic hierarchy.

**Intended learning outcomes**

- The students possess a fundamental and applicable knowledge in the areas of Gödel numbers, countable functions, decidable and countable sets, halting problem, m-reducibility, creative and productive sets, relative computability, Turing reduction, countable degrees, arithmetic hierarchy.

**Courses**

- (type, number of weekly contact hours, language — if other than German)
  - V (2) + Ü (2)

**Method of assessment**

- (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
  - written examination (approx. 60 to 120 minutes).
  - If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
  - Language of assessment: German and/or English creditable for bonus

**Allocation of places**

- --

**Additional information**

- Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits):
  - AT, SE, IT, IS, GE

**Referred to in LPO I**

- (examination regulations for teaching-degree programmes)
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<tbody>
<tr>
<td>1 semester</td>
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</table>

**Contents**

Fundamental principles of bioinformatics.

**Intended learning outcomes**

Students are proficient in methods for the analysis of DNA and protein databases.

**Courses**
(type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

**Method of assessment**
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English creditable for bonus

**Allocation of places**

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**Additional information**

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**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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## Module Title

**Compiler Construction**

### Abbreviation

10-I=CB-161-m01

### Module Coordinator

holder of the Chair of Computer Science II

### Module Offered by

Institute of Computer Science

### ECTS

5

### Method of Grading

Numerical grade

### Only after Succ. Comple. of Module(s)

--

### Duration

1 semester

### Module Level

Graduate

### Other Prerequisites

--

### Contents

Lexical analysis, syntactic analysis, semantics, compiler generators, code generators, code optimisation.

### Intended Learning Outcomes

The students possess knowledge in the formal description of programming languages and their compilation. They are able to perform transformations between them with the help of finite automata, push-down automata and compiler generators.

### Courses

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<td>Ü</td>
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### Method of Assessment

Written examination (approx. 60 to 120 minutes). If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Language of assessment: German and/or English

### Creditable for Bonus

Allocable for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): SE, IT, IS, GE

### Additional Information

Referenced in LPO I (examination regulations for teaching-degree programmes)
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</table>

**Contents**

- Syntax and semantics of definite and normal logic programs
- Model, proof, and fixpoint theory
- Connection to relational databases
- Evaluation methods for Datalog
- Negation and stratification
- Structural properties of logic programs: recursion, equivalence, transformation
- Outlook on disjunctive logic programs

**Intended learning outcomes**

- The students have fundamental and practicable knowledge about Datalog (including negation).
- They are able to compactly implement declarative programs in Datalog and to compare existing programs w.r.t. their equivalence and other properties.

**Courses** (type, number of weekly contact hours, language — if other than German)

- V (2) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

- Written examination (approx. 60 to 120 minutes).
- If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
- Language of assessment: German and/or English creditable for bonus

**Allocation of places**

- --

**Additional information**

- Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): AT, SE, IT, IS.

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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<td>1 semester</td>
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</table>

**Contents**

Logic-relational programming paradigm, top-down evaluation with SLD(NF) resolution. Introduction to the logic programming language Prolog: recursion, predicate-oriented programming, backtracking, cut, side effects, aggregations. Connection to (deductive) databases. Comparison with Datalog, short introduction of advanced concepts like constraint logic programming.

**Intended learning outcomes**

The students have fundamental and practicable knowledge of logic programming. They are able to implement compact and declarative programs in Prolog, and to compare this approach to the traditional imperative programming paradigm.

**Courses**

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**Method of assessment**

written examination (approx. 60 to 120 minutes). If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Language of assessment: German and/or English creditable for bonus

**Allocation of places**

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**Additional information**

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): AT, SE, IT, IS.

**Referred to in LPO I**

(examination regulations for teaching-degree programmes) --
Module title | Abbreviation
--- | ---
E-Learning | 10-I=EL-161-m01

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<tr>
<td>holder of the Chair of Computer Science VI</td>
<td>Institute of Computer Science</td>
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ECTS | Method of grading | Only after succ. compl. of module(s)
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5 | numerical grade | --

Duration | Module level | Other prerequisites
--- | --- | ---
1 semester | graduate | --

Contents
Learning paradigms, learning system types, author systems, learning platforms, standards for learning systems, intelligent tutoring systems, student models, didactics, problem-oriented learning and case-based training systems, adaptive tutoring systems, computer-supported cooperative learning, evaluation of learning systems.

Intended learning outcomes
The students possess a theoretical and practical knowledge about eLearning and are able to assess possible applications.

Courses (type, number of weekly contact hours, language — if other than German)
V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places
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Additional information
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits):
SE, IT, IS, HCI, GE

Referred to in LPO I (examination regulations for teaching-degree programmes)
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Module title | Abbreviation
--- | ---
Programming with neural nets | 10-I=PNN-182-m01

Module coordinator | Module offered by
holder of the Chair of Computer Science VI | Institute of Computer Science

ECTS | Method of grading | Only after succ. compl. of module(s)
--- | --- | ---
5 | numerical grade | --

Duration | Module level | Other prerequisites
--- | --- | ---
1 semester | graduate | --

**Contents**

Overview over NN, implementation of important NN-architectures like FCN, CNN and LSTMs, practical example for NN-architectures, among others in the area of image and language processing.

**Intended learning outcomes**

Knowledge about possible applications and limitations of NN, for important architectures (e.g. FCN, CNN, LSTM) and how they are implemented in NN-tools like Tensorflow/Keras, ability to program network structures from literature, to prepare data and solve concrete tasks for NN.

**Courses** (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).

If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Language of assessment: German and/or English creditable for bonus

**Allocation of places**

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**Additional information**

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): SE, IT, IS, HCI, GE.

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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<td>Machine Learning for Natural Language Processing</td>
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**Contents**

The lecture conveys advanced knowledge about methods in computational text processing. To this end, it presents state of the art models and techniques in the area of machine learning, as well as their technical background, and their respective applications in Natural Language Processing. As one important building block of almost all modern NLP-models, different techniques for learning representations of words, so called Word Embeddings, are presented. Starting from this we cover, among others, models from the area of Deep Learning, like CNNs, RNNs and Sequence-to-Sequence architectures. The theoretical foundations of these models, like their training with Backpropagation, are also covered in depth. For all models presented in the lecture, we show their application to problems like sentiment analysis, text generation and machine translation in practice.

**Intended learning outcomes**

The participants have solid knowledge on problems and methods in the area of computational text processing and are able to identify and apply suitable methods for a specific task.

**Courses** (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).

If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Language of assessment: German and/or English creditable for bonus

**Allocation of places**

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**Additional information**

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): AT, IS, HCI.

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

--
### Module title
Introduction into Human-Computer Interaction

### Abbreviation
10-I=HCI-161-m01

### Module coordinator
holder of the Chair of Computer Science IX

### Module offered by
Institute of Computer Science

### ECTS
5

### Method of grading
numerical grade

### Only after succ. compl. of module(s)
--

### Duration
1 semester

### Module level
graduate

### Other prerequisites
--

### Contents
Human-Computer Interaction is concerned with the design, evaluation and implementation of interactive computing systems for human use and with the study of major phenomena surrounding them. This course gives an introduction into the principle biological, physiological, and psychological constraints as defined by the human user and relates these constraints to the conceptual and technical solutions of today’s computer systems and existing as well as prospective interaction metaphors between humans and computers. The course covers topics about human perception and cognition, memory and attention, the design of interactive systems, prominent evaluation methods, the principles of computer systems, typical input processing techniques, interface technology, and examples of typical interaction metaphors, from text-based input to graphical desktops to multimodal interfaces. Accompanying lab-work will introduce students to typical tasks involved in this field, i.e., prominent evaluation methods and prototyping of interfaces.

### Intended learning outcomes
After the course, the students will have a broad understanding of the underlying principles of human users and computer systems. They will understand the constraints and capabilities of current user interfaces and they will learn about the necessary steps applied in user-centered design and development approaches.

### Courses
(type, number of weekly contact hours, language — if other than German)

V (3) + Ü (1)

### Method of assessment
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
presentation of project results (approx. 30 minutes)
Language of assessment: German and/or English creditable for bonus

### Allocation of places
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### Additional information
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): HCI.

Referred to in LPO I (examination regulations for teaching-degree programmes)

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<td>graduate</td>
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</table>

**Contents**

Models of embedded systems, implementation methods (ASIC, AISIP, micro controller), verification of embedded systems, implementation planning static, periodic and dynamic, binding problems, hardware synthesis, software synthesis.

**Intended learning outcomes**

The students are familiar with the technical possibilities for the design of embedded systems and master the most important techniques for the modelling, verification and optimisation of such systems in hardware and software.

**Courses**

(type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)

**Method of assessment**

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).

If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Language of assessment: German and/or English creditable for bonus

**Allocation of places**

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**Additional information**

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits):

AT, SE, ES, LR, GE

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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**Module coordinator**

holder of the Chair of Computer Science II

**Module offered by**

Institute of Computer Science

**ECTS** | Method of grading | Only after succ. compl. of module(s) |
---|---|---|
5 | numerical grade | -- |

**Duration**

1 semester

**Module level**

graduate

**Other prerequisites**

--

**Contents**

Program analysis, model creation in software engineering, program quality, test of programs, process models.

**Intended learning outcomes**

The students are able to analyse programs, to use testing frameworks and metrics as well as to judge program quality.

**Courses** (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).

If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Language of assessment: German and/or English creditable for bonus

**Allocation of places**

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**Additional information**

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): SE,JS,ES,GE

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>Information Retrieval</td>
<td>10-I=IR-161-m01</td>
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<th>Module offered by</th>
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<tr>
<td>Dean of Studies Informatik (Computer Science)</td>
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<td>1 semester</td>
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</table>

**Contents**

- IR models (e.g. Boolean and vector space model, evaluation),
- processing of text (tokenising, text properties),
- data structures (e.g. inverted index),
- query elements (e.g. query operations, relevance feedback, query languages and paradigms, structured queries),
- search engine (e.g. architecture, crawling, interfaces, link analysis),
- methods to support IR (e.g. recommendation systems, text clustering and classification, information extraction).

**Intended learning outcomes**

The students possess theoretical and practical knowledge in the area of information retrieval and have acquired the technical know-how to create a search engine.

**Courses** (type, number of weekly contact hours, language — if other than German)

- V (2) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

- written examination (approx. 60 to 120 minutes).

  If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

  Language of assessment: German and/or English creditable for bonus

**Allocation of places**

- --

**Additional information**

- Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits):
  - IT, IS, HCI, GE

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

- --
Module title
3D User Interfaces

Abbreviation
10-HCI=3DUI-161-m01

Module coordinator
holder of the Chair of Computer Science IX

Module offered by
Institute of Computer Science

ECTS
5

Method of grading
numerical grade

Only after succ. compl. of module(s)

Duration
1 semester

Module level
graduate

Other prerequisites
--

Contents
This module will give students the opportunity to learn about the specificities of 3D User Interfaces (3DUI) development using Virtual, Augmented or Mixed Reality technologies. The module content will be mainly dedicated to learn and practice the skills essential to the design and implementation of high-quality 3D interaction techniques. Design guidelines as well as classical and innovative 3D Interaction techniques will be studied. In addition, the course will address novel research themes such as 3D interaction for large displays and games; and integrating 3DUIs with mobile devices, robotics, and the environment. Students will be assessed through a group practical project (team work), which will consist of a program, a presentation, a technical report (2 ages) and a video. Previous years, the assignment replicated the IEEE 3DUI Contest 2011, where teams of students competed between each other to find the best solution (see results at https://www.youtube.com/watch?v=gYs-pBW7Agc and https://www.youtube.com/watch?v=gYs-pBW7Agc)

Intended learning outcomes
After the course, the students will gain a solid background on the theory and the methods to create your own 3D spatial interfaces. They will have a broad understanding of the particular difficulties of designing and developing spatial interfaces, as well as evaluating then. Students will also learn about traditional and novel 3D input/output devices (e.g., motion tracking system and Head-mounted Display).

Courses (type, number of weekly contact hours, language — if other than German)
V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
presentation of project results (approx. 30 minutes)
Language of assessment: German and/or English creditable for bonus

Allocation of places
--

Additional information
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Referred to in LPO I (examination regulations for teaching-degree programmes)
--
## Module Catalogue for the Subject
### Computer Science
#### Master's with 1 major, 120 ECTS credits

<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>Computational Complexity II</td>
<td>10-I=KT2-161-m01</td>
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<tr>
<td>1 semester</td>
<td>graduate</td>
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</table>

### Contents

Properties of NP-complete sets, autoreducibility, interactive proof systems, polynomial time hierarchy, complexity of probabilistic algorithms.

### Intended learning outcomes

The students possess a fundamental and applicable knowledge in the areas of properties of NP-complete sets, autoreducibility, interactive proof systems, polynomial time hierarchies, complexity of probabilistic algorithms.

### Courses

(type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

### Method of assessment

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).

If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Language of assessment: German and/or English creditable for bonus

### Allocation of places

--

### Additional information

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits):

AT,SE,IT,ES

### Referred to in LPO I

(examination regulations for teaching-degree programmes)

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<table>
<thead>
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<th>Module title</th>
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<td>Artificial Intelligence 1</td>
<td>10-I=KI1-161-m01</td>
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<th>Duration</th>
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<tr>
<td>1 semester</td>
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</table>

**Contents**

Intelligent agents, uninformed and heuristic search, constraint problem solving, search with partial information, propositional and predicate logic and inference, knowledge representation.

**Intended learning outcomes**

The students possess theoretical and practical knowledge about artificial intelligence in the area of agents, search and logic and are able to assess possible applications.

**Courses** (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

- written examination (approx. 60 to 120 minutes).
- If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
- Language of assessment: German and/or English
- creditable for bonus

**Allocation of places**

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**Additional information**

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits):

AT, SE, IS, HCI

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

--
Module title: Artificial Intelligence 2
Abbreviation: 10-I=KI2-161-m01

Module coordinator: holder of the Chair of Computer Science VI
Module offered by: Institute of Computer Science

ECTS: 5
Method of grading: Only after succ. compl. of module(s)
Numerical grade: --
Duration: 1 semester
Module level: graduate
Other prerequisites: --

Contents:
Planning, probabilistic closure and Bayesian networks, utility theory and decidability problems, learning from observations, knowledge while learning, neural networks and statistical learning methods, reinforcement learning, processing of natural language.

Intended learning outcomes:
The students possess theoretical and practical knowledge about artificial intelligence in the area of probabilistic closure, learning and language processing and are able to assess possible applications.

Courses:
V (2) + Ü (2)

Method of assessment:
written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places:
--

Additional information:
Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): AT, SE, IS, HCI, GE
Referred to in LPO I (examination regulations for teaching-degree programmes):
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<td>Performance Evaluation of Distributed Systems</td>
<td>10-I=LVS-161-m01</td>
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<tr>
<td>1 semester</td>
<td>graduate</td>
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</table>

**Contents**

Traffic theoretic models, fundamental concepts of theory of probability, transformation techniques, stochastic processes, methods for performance analysis of technical systems, queue-/traffic theory, analysis of Markov, non-Markov and time critical systems, matrix analytical method, practical examples for performance analysis of computer systems and networks: throughput and goodput analysis and other characteristics.

**Intended learning outcomes**

The students possess the methodic knowledge and the practical skills necessary to model technical systems by means of the theory of probability and mathematical statistics.

**Courses**

(type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)

**Method of assessment**

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).

If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Language of assessment: German and/or English creditable for bonus

**Allocation of places**

--

**Additional information**

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): AT, IT, GE

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

--
Module title | Abbreviation
---|---
Mathematical Logic | 10-I=ML-161-m01

Module coordinator | Module offered by
Dean of Studies Informatik (Computer Science) | Institute of Computer Science

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Contents
Propositional logic, first-order predicate logic, proof and deduction, Gödel’s completeness theorem, Tarski theorem, Gödel’s incompleteness theorem, undecidability and nonaxiomatisability of elemental arithmetic.

Intended learning outcomes
The students possess a fundamental and applicable knowledge in the areas of propositional logic, first-order predicate logic, proof and deduction, Gödel’s completeness theorem, Tarski theorem, Gödel’s incompleteness theorem, undecidability and nonaxiomatisability of elemental arithmetic.

Courses (type, number of weekly contact hours, language — if other than German)
V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English creditable for bonus

Allocation of places
--

Additional information
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): AT, SE, IS, ES

Referred to in LPO I (examination regulations for teaching-degree programmes)
--
### Module title
Medical Informatics

### Abbreviation
10-I=MI-161-m01

#### Module coordinator
holder of the Chair of Computer Science VI

#### Module offered by
Institute of Computer Science

#### ECTS
5

#### Method of grading
numerical grade

#### Only after succ. compl. of module(s)
--

#### Duration
1 semester

#### Module level
graduate

#### Other prerequisites
--

### Contents
Electronic patient folder, coding of medical data, hospital information systems, operation of computers in infirmary and functional units, medical decision making and assistance systems, statistics and data mining in medical research, case-based training systems in medical training.

### Intended learning outcomes
The students possess theoretical and practical knowledge about the application of computer science methods in medicine.

### Courses
(type, number of weekly contact hours, language — if other than German)

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<tr>
<th>Type</th>
<th>Number of Weekly Contact Hours</th>
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#### Method of assessment
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

- **written examination** (approx. 60 to 120 minutes).
  - If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
  - Language of assessment: German and/or English
  - Creditable for bonus

### Allocation of places
--

### Additional information
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): SE, IT, IS, HCI, GE

### Referred to in LPO I
(examination regulations for teaching-degree programmes)
--
Module title: Performance Engineering & Benchmarking of Computer Systems
Abbreviation: 10-I=PEB-161-m01

Module coordinator: holder of the Chair of Computer Science II
Module offered by: Institute of Computer Science
ECTS: 5
Method of grading: numerical grade
Only after succ. compl. of module(s): --
Duration: 1 semester
Module level: graduate
Other prerequisites: --

Contents:
Introduction to performance engineering of commercial software systems, performance measurement techniques, benchmarking of commercial software systems, modelling for performance prediction, case studies.

Intended learning outcomes:
The students possess a fundamental and applicable knowledge in the areas of performance metrics, measurement techniques, multi-factorial variance analysis, data analysis with R, benchmark approaches, modelling with queue networks, modelling methods, resource demand approximation, petri nets.

Courses:
(type, number of weekly contact hours, language — if other than German)
V (2) + Ü (2)

Method of assessment:
type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus
written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
credible for bonus

Allocation of places:
--

Additional information:
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits):
SE, IT, ES, HCI, GE

Referred to in LPO I:
(examination regulations for teaching-degree programmes)
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<table>
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<td>Professional Project Management</td>
<td>10-I=PM-182-m01</td>
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<th>Other prerequisites</th>
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<tr>
<td>1 semester</td>
<td>graduate</td>
<td>Simultaneous completion of module 10-I=PRJAK is recommended.</td>
</tr>
</tbody>
</table>

**Contents**

Project goals, project assignment, project success criteria, business plan, environment analysis and stakeholder management, initialisation, definition, planning, execution/control, finishing of projects, reporting, project communication and marketing, project organisation, team building and development, opportunity and risk management; conflict and crisis management, change and claim management; contract and procurement management, quality management, work techniques, methods and tools; leadership and social skills in project management, program management, multiproject management, project portfolio management, PMOs; peculiarities of software projects; agile project management/SCRUM, combination of classic and agile methods.

**Intended learning outcomes**

The students possess practically relevant knowledge about the topics of production management and/or professional project management. They are familiar with the critical success criteria and are able to initiate, define, plan, control and review projects.

**Courses** (type, number of weekly contact hours, language — if other than German)

V (4)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English creditable for bonus

**Allocation of places**

--

**Additional information**

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): SE, IT, IS, ES, LR, HCI, GE.

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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<td>Computer Arithmetic</td>
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</table>

**Contents**

Spaces of numerical computation, raster and rounding, definition and implementation of computational arithmetic and interval calculation.

**Intended learning outcomes**

The students possess knowledge about the spaces of numerical computation, raster and roundings, definition and implementation of computational arithmetic and interval calculation. They master the application of algorithms.

**Courses** (type, number of weekly contact hours, language — if other than German)

- V (2) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

- written examination (approx. 60 to 120 minutes).
- If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
- Language of assessment: German and/or English
- creditable for bonus

**Allocation of places**

- --

**Additional information**

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits):

- AT, ES

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

- --
### Module title
Robotics 1

### Abbreviation
10-l-RO1-182-m01

### Module coordinator
holder of the Chair of Computer Science VII

### Module offered by
Institute of Computer Science

### ECTS
8

### Method of grading
numerical grade

### Only after succ. compl. of module(s)
--

### Duration
1 semester

### Module level
graduate

### Other prerequisites
--

### Contents
History, applications and properties of robots, direct kinematics of manipulators: coordinate systems, rotations, homogenous coordinates, axis coordinates, arm equation. Inverse kinematics: solution properties, end effector configuration, numerical and analytical approaches, examples of different robots for analytical approaches. Workspace analysis and trajectory planning, dynamics of manipulators: Lagrange-Euler model, direct and inverse dynamics. Mobile robots: direct and inverse kinematics, propulsion system, tricycle, Ackermann steering, holonomous and non-holonomous restrictions, kinematic classification of mobile robots, posture kinematic model. Movement control and path planning: roadmap methods, cell decomposition methods, potential field methods. Sensors: position sensors, speed sensors, distance sensors.

### Intended learning outcomes
The students master the fundamentals of robot manipulators and vehicles and are, in particular, familiar with their kinematics and dynamics as well as the planning of paths and task execution.

### Courses (type, number of weekly contact hours, language — if other than German)
- V (4) + Ü (2)
  - Module taught in: English

### Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
- written examination (approx. 60 to 90 minutes)
  - Separate written examination for Master's students.
  - Language of assessment: English
  - creditable for bonus

### Allocation of places
--

### Additional information
Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): IS, ES, LR, HCI, GE.

### Referred to in LPO I (examination regulations for teaching-degree programmes)
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<td>1 semester</td>
<td>graduate</td>
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</table>

**Contents**

Foundations of dynamic systems, controllability and observability, controller design through pole assignment: feedback and feed-forward, state observer, feedback with state observer, time discrete systems, stochastic systems: foundations of stochastics, random processes, stochastic dynamic systems, Kalman filter: derivation, initialising, application examples, problems of Kalman filters, extended Kalman filter.

**Intended learning outcomes**

The students master all fundamentals that are necessary to understand Kalman filters and their use in applications of robotics. The students possess a knowledge of advanced controller and observer methods and recognise the connections between the dual pairs controllability - observability as well as controller design and observer design. They also recognise the relationship between the Kalman filter as a state estimator and an observer.

**Courses** (type, number of weekly contact hours, language — if other than German)

V (4) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 90 minutes)  
creditable for bonus

**Allocation of places**

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**Additional information**

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): IT, ES, LR

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

--
Module title | Abbreviation
---|---
Discrete Event Simulation | 10-I=ST-161-m01

Module coordinator | Module offered by
holder of the Chair of Computer Science III | Institute of Computer Science

ECTS | Method of grading | Only after succ. compl. of module(s)
---|---|---
8 | numerical grade | --

Duration | Module level | Other prerequisites
---|---|---
1 semester | graduate | --

Contents
Introduction to simulation techniques, statistical groundwork, creation of random numbers and random variables, random sample theory and estimation techniques, statistical analysis of simulation values, inspection of measured data, planning and evaluation of simulation experiments, special random processes, possibilities and limits of model creation and simulation, advanced concepts and techniques, practical execution of simulation projects.

Intended learning outcomes
The students possess the methodic knowledge and the practical skills necessary for the stochastic simulation of (technical) systems, the evaluation of results and the correct assessment of the possibilities and limits of simulation methods.

Courses (type, number of weekly contact hours, language — if other than German)
V (4) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English creditable for bonus

Allocation of places
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Additional information
Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): IT,IS,ES,GE

Referred to in LPO I (examination regulations for teaching-degree programmes)
--
Module title | Abbreviation
---|---
Real-Time Interactive Systems | 10-HCI=RIS-182-m01

**Module coordinator**

holder of the Chair of Computer Science IX

**Module offered by**

Institute of Computer Science

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**Duration** | **Module level** | **Other prerequisites**
---|---|---
1 semester | graduate | --

**Contents**

This course provides an introduction into the requirements, concepts, and engineering art of highly interactive human-computer systems. Such systems are typically found in perceptual computing, Virtual, Augmented, Mixed Reality, computer games, and cyber-physical systems. Lately, these systems are often termed Real-Time Interactive Systems (RIS) due to their common aspects.

The course covers theoretical models derived from the requirements of the application area as well as common hands-on and novel solutions necessary to tackle and fulfill these requirements. The first part of the course will concentrate on the conceptual principles characterizing real-time interactive systems. Questions answered are: What are the main requirements? How do we handle multiple modalities? How do we define the timeliness of RIS? Why is it important? What do we have to do to assure timeliness? The second part will introduce a conceptual model of the mission-critical aspects of time, latencies, processes, and events necessary to describe a system's behavior. The third part introduces the application state, it's requirements of distribution and coherence, and the consequences these requirements have on decoupling and software quality aspects in general. The last part introduces some potential solutions to data redundancy, distribution, synchronization, and interoperability. Along the way, typical and prominent state-of-the-art approaches to reoccurring engineering tasks are discussed. This includes pipeline systems, scene graphs, application graphs (aka field routing), event systems, entity and component models, and others. Novel concepts like actor models and ontologies will be covered as alternative solutions. The theoretical and conceptual discussions will be put into a practical context of today's commercial and research systems, e.g., X3D, instant reality, Unity3d, Unreal Engine 4, and Simulator X.

**Intended learning outcomes**

After the course, the students will have a solid understanding of the boundary conditions defined by both, the physiological and psychological characteristics of the human users as well as by the architectures and technological characteristics of today's computer systems. Participants will gain a solid understanding about what they can expect from today's technological solutions. They will be able to choose the appropriate approach and tools to solve a given engineering task in this application area and they will have a well-founded basis enabling them to develop alternative approaches for future real-time interactive systems.

**Courses** (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).

If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Language of assessment: German and/or English creditable for bonus

**Allocation of places**

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**Additional information**

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): HCI. Cf. Section 3 Subsection 3 Sentence 8 FSB (subject-specific provisions).
Referred to in LPO I (examination regulations for teaching-degree programmes)

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<td>Software Architecture</td>
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<td>1 semester</td>
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**Contents**

Current topics in the area of aerospace.

**Intended learning outcomes**

The students possess a fundamental and applicable knowledge about advanced topics in software engineering with a focus on modern software architectures and fundamental approaches to model-driven software engineering.

**Courses**

(type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

**Method of assessment**

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English creditable for bonus

**Allocation of places**

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**Additional information**

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits):
SE, IT, ES

**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

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**Contents**

- Introduction: history of space flight, system design of spacecraft.
- Space dynamics: two-body dynamics, Kepler orbits, disturbance forces, transfer orbits.
- Mission analysis: earth and sun-synchronous orbits, shadows, solar angle of incidence.
- Thermal control of satellites: thermal analysis, thermal design and technologies, verification of thermal designs.
- Telecommunication: ground contact analysis, data transmission, satellite monitoring (telemetry, telecommando).
- Structure and mechanisms.
- Energy systems: primary, secondary, management, power generation: solar cells.
- On-board data processing.
- Propulsion systems.
- Tests (mechanical, electrical).
- Operation of spacecraft.
- Ground segment.

**Intended learning outcomes**

The students master system aspects of the layouting of technical systems. Using the example of spacecraft, major subsystems and their integration into a working whole are being analysed.

**Courses** (type, number of weekly contact hours, language — if other than German)

- V (4) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

- written examination (approx. 60 to 120 minutes)
- creditable for bonus

**Allocation of places**

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**Additional information**

- Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): ES, LR
- Referred to in LPO I (examination regulations for teaching-degree programmes)

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## Module title

Machine Learning (for User Interfaces)

### Abbreviation

10-HCl=MLUI-161-m01

### Module coordinator

holder of the Chair of Computer Science IX

### Module offered by

Institute of Computer Science

### ECTS

5

### Method of grading

numerical grade

### Only after succ. compl. of module(s)

--

### Duration

1 semester

### Module level

graduate

### Other prerequisites

--

## Contents

Machine learning is the science of getting computers to act without being explicitly programmed. In the past decade, machine learning has given us practical speech recognition, effective web search, self-driving cars, and a vastly improved understanding of the human genome. Machine learning is so pervasive today that you probably use it dozens of times a day without knowing it. It is one of today's prominent paradigms in HCI applicable in all areas where the understanding of user input of high variability, specifically for natural interactions using, e.g., gesture, speech, or eye-gaze, is paramount. Many researchers also think it is the best way to make progress towards human-level AI.

In this course, students will learn about the most effective machine learning techniques, and gain practice implementing them and getting them to work. Students not only learn the theoretical underpinnings of learning, but also gain the practical know-how needed to quickly and powerfully apply these techniques to new problems. Finally, they learn about some of Silicon Valley's best practices in innovation as it pertains to machine learning and AI.

This course provides a broad introduction to machine learning, data-mining, and statistical pattern recognition. Topics include: (i) Supervised learning (parametric/non-parametric algorithms, support vector machines, kernels, neural networks). (ii) Unsupervised learning (clustering, dimensionality reduction, recommender systems, deep learning). (iii) Best practices in machine learning (bias/variance theory; innovation process in machine learning and AI). The course will also draw from numerous case studies and applications, so that you’ll also learn how to apply learning algorithms to building gesture-based and multimodal interfaces, text and speech understanding (web search, anti-spam), smart robots (perception, control), computer vision, medical informatics, audio, database mining, and other areas.

## Intended learning outcomes

After the course, the students will be able to solve machine learning tasks on their own using assistive technologies, e.g., like Octave. In addition, they will be able to derive main principles and apply these in own programs. Students will be able to choose the appropriate approach and tools to solve a given machine learning task in various application area, specifically in HCI.

## Courses (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

## Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

presentation of project results (approx. 40 minutes)

Language of assessment: German and/or English creditable for bonus

## Allocation of places

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## Additional information

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## Referred to in LPO 1 (examination regulations for teaching-degree programmes)

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Module title: Probabilistic Inference

Abbreviation: 10-l=Pl-172-m01

Module coordinator: Dean of Studies Informatik (Computer Science)

Module offered by: Institute of Computer Science

ECTS: 5

Method of grading: Numerical grade

Other prerequisites: --

Duration: 1 semester

Module level: Graduate

Contents:
- Introduction, Review, and Decision Theory
- Independence, Belief Networks, Markov Networks, Factor Graphs
- Inference in Trees
- Maximum likelihood, Learning Markov Random Fields, Approximate Inference
- Sampling, Support Vector Machines, Computer Vision Kernels, Gaussian Processes

Intended learning outcomes:
The students are able to master probabilistic inference and to program small python programs for applying these methods.

Courses:
- V (2) + Ü (2)

Method of assessment:
- Written examination (approx. 60 to 120 minutes).
- If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Language of assessment: German and/or English

Allocation of places: --

Additional information:
- Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): AT, IT, IS, HCI.
- Referred to in LPO I (examination regulations for teaching-degree programmes): --
### Visualization of Graphs

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<td>Visualization of Graphs</td>
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#### Module coordinator
holder of the Chair of Computer Science I

#### Module offered by
Institute of Computer Science

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#### Duration
1 semester

#### Module level
graduate

#### Other prerequisites
--

### Contents
This course covers the most important algorithms to draw graphs. Methods from the course *Algorithmische Graphentheorie (Algorithmic Graph Theory)* such as divide and conquer, flow networks, integer programming and the planar separator theorem will be used. We will become familiar with measures of quality of a graph drawing as well as algorithms to optimise these measures.

### Intended learning outcomes
The participants get an overview of graph visualisation and become familiar with typical tools. They consolidate their knowledge about the modelling and solving of problems with the help of graphs and graph algorithms.

### Courses
V (2) + Ü (2)

### Method of assessment
written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English creditable for bonus

### Allocation of places
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### Additional information
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): AT, IT, HCI, GE

### Referred to in LPO I
(examination regulations for teaching-degree programmes)

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**Contents**

Selected topics in algorithmics and theory.

**Intended learning outcomes**

The students understand the basic approach of games engineering. They are able to understand the solutions of complex problems in this area and apply them to similar questions.

**Courses** (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).

If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Language of assessment: German and/or English creditable for bonus

**Allocation of places**

--

**Additional information**

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): GE.

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

--
### Module title
**Selected Topics in Algorithms**

### Abbreviation
10-I=AKA-161-m01

### Module coordinator
holder of the Chair of Computer Science I

### Module offered by
Institute of Computer Science

### ECTS
5

### Method of grading
numerical grade

### Only after succ. compl. of module(s)
--

### Duration
1 semester

### Module level
graduate

### Other prerequisites
--

### Contents
Selected topics in algorithmics and theory.

### Intended learning outcomes
The students understand the basic approach of algorithmic computer science. They are able to understand the solutions of complex problems in this area and apply them to similar questions.

### Courses
(type, number of weekly contact hours, language — if other than German)

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### Method of assessment
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

- written examination (approx. 60 to 120 minutes).
  - If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
  - Language of assessment: German and/or English
  - creditable for bonus

### Allocation of places
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### Additional information

- Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits):
  - AT

### Referred to in LPO I
(examination regulations for teaching-degree programmes)

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Module title: Selected Topics in Theory
Abbreviation: 10-I=AKT-161-m01

Module coordinator: holder of the Chair of Computer Science I
Module offered by: Institute of Computer Science
ECTS: 5
Method of grading: numerical grade
Only after succ. compl. of module(s): --
Duration: 1 semester
Module level: graduate
Other prerequisites: --

Contents:
Selected topics in algorithmics and theory.

Intended learning outcomes:
The students understand the basic approach of theoretical computer science. They are able to understand the solutions of complex problems in this area and apply them to similar questions.

Courses:
(type, number of weekly contact hours, language — if other than German)
V (2) + Ü (2)

Method of assessment:
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English creditable for bonus

Allocation of places:
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Additional information:
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits):
AT

Referred to in LPO I:
(examination regulations for teaching-degree programmes)
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**Contents**
Selected topics in software engineering.

**Intended learning outcomes**
The students possess an advanced knowledge about selected aspects of software engineering.

**Courses** (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English creditable for bonus

**Allocation of places**
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**Additional information**
Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): SE.

**Referred to in LPO I** (examination regulations for teaching-degree programmes)
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### Contents

Selected topics in IT security.

### Intended learning outcomes

The students possess an advanced knowledge in the area of IT security. They are able to understand solutions to complex problems in this area and to transfer them to related questions.

### Courses

(type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

Module taught in: English

### Method of assessment

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).

If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Language of assessment: English

creditable for bonus

### Allocation of places

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### Additional information

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): SE, JS, LR, HCI, ES.

Referred to in LPO I (examination regulations for teaching-degree programmes)

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Module title | Abbreviation
---|---
Selected Topics in Internet Technologies | 10-I=AKIT-161-m01

Module coordinator
holder of the Chair of Computer Science III

Module offered by
Institute of Computer Science

ECTS | Method of grading | Only after succ. compl. of module(s)
---|---|---
5 | numerical grade | --

Duration | Module level | Other prerequisites
---|---|---
1 semester | graduate | --

Contents
Selected topics in computer communication, for example design aspects of future internet structures: setup and control structures of the internet, multicast protocols, protocols for multimedia communication, optical networks, control mechanisms for redundant and real-time communication networks, p2p networks, ad-hoc networks, or -- new concepts and technologies in mobile communication: digital modulation, signal propagation, channel coding, modern transmission technologies (adaptive modulation and encoding, hybrid ARQ, OFDM, MIMO), mac layer, mobileIP, routing in ad-hoc networks, vertical handover, UMTS IP multimedia subsystem, or -- planning and management methods in telecommunication networks: planning methods (forward engineering, reverse engineering), network management paradigms (central and decentral), framework for network management (IETF traffic engineering, ITU-T TMN, OSI management), planning and management methods (IP management mechanisms, network design, measurement, acquisition and evaluation of traffic and performance data, visualisation, result handling, simulation and analysis of networks), management tools, outlook and perspectives, or -- other current topics.

Intended learning outcomes
The students have a knowledge of advanced and current topics in the management and design of modern wired and wireless communication systems.

Courses
V (2) + Ü (2)

Method of assessment
written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English
creditable for bonus

Allocation of places
--

Additional information
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): IT.

Referred to in LPO I (examination regulations for teaching-degree programmes)
--
Module title
Selected Topics in Intelligent Systems

Abbreviation
10-I=AKIS-161-m01

Module coordinator
holder of the Chair of Computer Science VI

Module offered by
Institute of Computer Science

ECTS
5

Method of grading
numerical grade

Only after succ. compl. of module(s)
--

Duration
1 semester

Module level
graduate

Other prerequisites
--

Contents
Selected topics in intelligent systems.

Intended learning outcomes
The students possess an advanced knowledge in the area of intelligent systems. They are able to understand solutions to complex problems in this area and to transfer them to related questions.

Courses
[type, number of weekly contact hours, language — if other than German]
V (2) + Ü (2)

Method of assessment
[type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus]
written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English creditable for bonus

Allocation of places
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Additional information
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): IS.

Referred to in LPO I
(examination regulations for teaching-degree programmes)
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<table>
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<td>Selected Topics in Embedded Systems</td>
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<tr>
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<td>graduate</td>
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</table>

### Contents
Selected topics in embedded systems.

### Intended learning outcomes
The students possess specialised knowledge in the area of embedded systems. They are able to understand solutions to complex problems in this area and to transfer them to related questions.

### Courses
(type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

### Method of assessment
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English creditable for bonus

### Allocation of places
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### Additional information
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): ES.

### Referred to in LPO I
(examination regulations for teaching-degree programmes)

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<table>
<thead>
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<td>NLP and Text Mining</td>
<td>10-I=STM-162-m01</td>
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<tr>
<td>1 semester</td>
<td>graduate</td>
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</table>

**Contents**

Foundations in the following areas: definition of NLP and text mining, properties of text, sentence boundary detection, tokenisation, collocation, N-gram models, morphology, hidden Markov models for tagging, probabilistic parsing, word sense disambiguation, term extraction methods, information extraction, sentiment analysis.

The students possess theoretical and practical knowledge about typical methods and algorithms in the area of text mining and language processing mostly for English. They are able to solve problems through the methods taught. They have gained experience in the application of text mining algorithms.

**Intended learning outcomes**

The students possess theoretical and practical knowledge about typical methods and algorithms in the area of text mining and language processing. They are able to solve practical problems with the methods acquired in class. They have gained experience in the application of text mining algorithms.

**Courses** (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

- written examination (approx. 60 to 120 minutes).
  If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Language of assessment: German and/or English

**Allocation of places**

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**Additional information**

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): AT, IT, HCI.

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

--
Module title | Abbreviation
--- | ---
Selected Topics in Aerospace Engineering | 10-I=AKLR-161-m01

Module coordinator | Module offered by
holder of the Chair of Computer Science VII | Institute of Computer Science

ECTS | Method of grading | Only after succ. compl. of module(s)
--- | --- | ---
5 | numerical grade | --

Duration | Module level | Other prerequisites
--- | --- | ---
1 semester | graduate | --

Contents
Selected topics in aerospace engineering, for example: satellite communication, rocket science, propulsion systems, sensors and actuators for orientation control, perturbation of orbits, interplanetary orbits, rendezvous and docking, design of space ships, design of planetary bases, life support systems, special aspects of operations, payloads, optical systems, RADAR, earth monitoring, thermo management, structure of space ships, special areas of navigation, space environment, environment simulation, verification and test of space faring systems, space astronomy and planet missions, space medicine and biology, material science, quality management, space law, aeroflight topics, avionics for airplanes, air traffic control, areal navigation, pilot interfaces, air traffic control, air traffic management.

Intended learning outcomes
The students possess an advanced knowledge about the respective topic of the selected area and are able to consider these foundations in their future plans of air or spaceborne systems.

Courses (type, number of weekly contact hours, language — if other than German)
V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Separate written examination for Master's students.
Language of assessment: German and/or English creditable for bonus

Allocation of places
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Additional information
Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): LR.

Referred to in LPO I (examination regulations for teaching-degree programmes)
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<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tr>
<td>Selected Topics in HCI</td>
<td>10-I=AKHCI-182-m01</td>
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<td>holder of the Chair of Computer Science IX</td>
<td>Institute of Computer Science</td>
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<td>1 semester</td>
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</table>

**Contents**

Selected topics in HCI.

**Intended learning outcomes**

The students understand the basic approach of human-computer interaction. They are able to understand the solutions to complex problems in this area and to transfer them to related questions.

**Courses** (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (60 to 120 minutes).

If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Language of assessment: German and/or English
creditable for bonus

**Allocation of places**

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**Additional information**

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): HCI.

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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<th>Other prerequisites</th>
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<td>1 semester</td>
<td>graduate</td>
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</table>

### Contents

Selected topics in computer science.

### Intended learning outcomes

The students are able to understand the solutions to complex problems in computer science and to transfer them to related questions.

### Courses

(type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

### Method of assessment

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English creditable for bonus

### Allocation of places

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### Additional information

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### Referred to in LPO I

(examination regulations for teaching-degree programmes)

--
Projects and Training
(max. 20 ECTS credits)
### Module title

**Space Systems Design**

### Abbreviation

10-I=RSE-182-m01

### Module coordinator

holder of the Chair of Computer Science VIII

### Module offered by

Institute of Computer Science

### ECTS

10

### Method of grading

numerical grade

### Only after succ. compl. of module(s)

--

### Duration

1 semester

### Module level

graduate

### Other prerequisites

--

### Contents

In the course of a semesterproject, a spacecraft system will be designed in a team. The selection of the spacecraft system is done anew each semester and draws inspiration from current trends and concrete research, often from the area of microsatellites, like "design of a nanosatellite mission for detection and observation of transient lunar phenomenons (TLP)".

### Intended learning outcomes

The students gain fundamental knowledge about the design of spacecraft systems. They are able to analyse the elementary design aspects, create requirements accordingly and consider them in their system design. With the help of the acquired knowledge of methods they are able to create dedicated tools and methods to support the design in the area of spacecraft systems. Also project management for the development of spacecraft systems will be trained.

### Courses (type, number of weekly contact hours, language — if other than German)

R (6)

### Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

project report (10 to 15 pages) and presentation of project (15 to 30 minutes)

Assessment offered: In the semester in which the course is offered (The project will not be repeated; there will not be another project with the same topic. Assessment can, therefore, only be offered for the project offered in the respective semester.)

Language of assessment: German and/or English

### Allocation of places

--

### Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): LR. Cf. Section 3 Subsection 3 Sentence 8 FSB (subject-specific provisions).

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

--
### Module title

Design of Planetary Bases and Orbital Stations

### Abbreviation

10-I=EPB-182-m01

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<th>Module level</th>
<th>Other prerequisites</th>
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<tr>
<td>1 semester</td>
<td>graduate</td>
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</table>

### Contents

In light of future human settlements across the solar system, this lecture will focus on the special aspects of planning of planetary bases. This will train the planning of a very complex spacecraft apart from its individual components like satellites. The content will be decided upon each semester (for example lunar base, mars base etc). The most important aspects like motivation, goals, prerequisites, constraints, environment, localization, construction and operation scenarios, planning of modules and structures, lifesupport, energy, communication, production, transport between earth and moon as well as mobility on the surface of the moon will be conceptually laid out and analyzed.

### Intended learning outcomes

The students gain fundamental knowledge about the planning of planetary bases and orbital bases. They are able to analyse the elementary aspects of planning, pose requirements and consider the system design. With the support of the acquired knowledge of methods they are able to create dedicated tools and processes to support the planning in the area of planetary bases and orbital stations. Also project management for the development of planetary bases and orbital stations will be trained.

### Courses

| type, number of weekly contact hours, language — if other than German |
|--------------------------|--------------------------|
| R (6)                    |                          |

### Method of assessment

<table>
<thead>
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<th>type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus</th>
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### Allocation of places

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**Additional information**

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): LR. Cf. Section 3 Subsection 3 Sentence 8 FSB (subject-specific provisions).

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

--
Module title: Practical course - Rocket Engineering and Payloads
Abbreviation: 10-I=PRT-182-m01

Module coordinator: holder of the Chair of Computer Science VIII
Module offered by: Institute of Computer Science

ECTS: 10
Method of grading: Only after succ. compl. of module(s)

Duration: 1 semester
Module level: graduate
Other prerequisites: --

Contents:
In this internship, students are supposed to acquire practical experience in the design, building, execution and analysis of rocket experiments (including their payload). The goal is the design, building and testing of rocket experiments and their payloads.

Intended learning outcomes:
The students gain fundamental knowledge about the design of spacecraft experiments, fundamental knowledge about rocket science, including launch preparations as well as the execution. They are able to analyse the elementary design aspects of rocket payloads, pose according requirements and respects those in the design. With the aid of the acquired methodic knowledge, they are able to apply dedicated tools and method in bigger projects.

Courses:
(type, number of weekly contact hours, language — if other than German)
P (6)

Method of assessment:
type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
report on practical course (4 to 5 pages) and presentation of results (15 to 30 minutes)
Language of assessment: German and/or English

Allocation of places:
--

Additional information:
Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): LR. Cf. Section 3 Subsection 3 Sentence 8 FSB (subject-specific provisions).

Referred to in LPO 1: (examination regulations for teaching-degree programmes)
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</table>

**Contents**

German contents available but not translated yet.

- Aufbau eines RV12 Kleinflugzeug - Elemente des RV12 (Aluminiumverarbeitung) - Aufbau eines Projektteams - Aufgaben und Verantwortungsverteilung - Qualitätssicherung - Dokumentation der Arbeiten - Bauen einiger Elemente des RV12 - Marketing und PR Aktivitäten

**Intended learning outcomes**

German intended learning outcomes available but not translated yet.


**Courses** (type, number of weekly contact hours, language — if other than German)

- R (6)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

- project report (10 to 15 pages) and presentation of project (15 to 30 minutes)

Language of assessment: German and/or English creditable for bonus

**Allocation of places**

--

**Additional information**

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): LR. Cf. Section 3 Subsection 3 Sentence 8 FSB (subject-specific provisions).

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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<td>Flight Simulator</td>
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</table>

### Contents

- Layout of A320 cockpit, instruments in an A320 cockpit, flight preparations, cold and dark start of an A320, flight route entry, flight execution, taxing, take-off, flight, landing, taxing, anomalies and emergencies

### Intended learning outcomes

The students possess the technical, theoretical and practical knowledge and skills to do a flight with an A320. Important: this is no licence to fly and it's not a pilot training.

### Courses

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### Method of assessment

- project report (10 to 15 pages) and presentation of project (15 to 30 minutes)
- Separate written examination for Master's students.

Language of assessment: German and/or English creditable for bonus

### Allocation of places

--

### Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): LR. Cf. Section 3 Subsection 3 Sentence 8 FSB (subject-specific provisions).

### Referred to in LPO I

(examination regulations for teaching-degree programmes)

--
Module title
Game Research Lab - Theory

Abbreviation
10-I=GRLT-182-m01

Module coordinator
holder of the Chair of Computer Science IX

Module offered by
Institute of Computer Science

ECTS
10

Method of grading
numerical grade

Duration
1 semester

Module level
graduate

Other prerequisites
--

Contents
The Game Research Labs are project-oriented, master-level courses. In accordance with the definition of Games Engineering, they concern themselves with the effective provision and the systematic application of principles, methods and tools for the development and application of comprehensive software systems for computer games. There are four different directions of Game Research Labs: Theory, Applications, Design and Architecture. All of them implement a scientific process during which the students develop a project based on preceding works and a novel idea or hypothesis worthwhile exploring. Typical steps in a Game Research Lab include a short literature survey, the development of a concept, its realisation and evaluation. Theoretical foundations of Games Engineering as well as their transfer and application are the focus of the "Game Research Lab - Theory". This comprises the application, extension and innovation of formal representations, mathematics, algorithmics, for instance in the areas of computer graphics, realtime physics computation or artificial intelligence. The application, adaptation and innovation of optimisation approaches, formal process descriptions and verification in the context of interactive simulations also lie in the scope of this Game Research Lab.

Intended learning outcomes
We recommend previous completion of basic courses in Games Engineering such as Interactive Computer Graphics, Asset Development and Interactive Artificial Intelligence. The Game Research Labs empower the students to retrace current scientific works in great detail, to improve their research skills and to deepen their expertise with respect to specific challenges in Games Engineering. Formal systems and their applications to challenges in Games Engineering are the focus of the "Game Research Lab - Theory". Accordingly, the students will deeply immerse themselves into relevant topics in order to learn about, understand and learn to apply existing theoretical approaches. Their application to the respective challenges will foster the students' knowledge and competencies in theory and Games Engineering.

Courses (type, number of weekly contact hours, language — if other than German)
R (4)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
project report (10 to 15 pages) and presentation of project (15 to 30 minutes)
Language of assessment: German and/or English
creditable for bonus

Allocation of places
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Additional information
Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): GE. Cf. Section 3 Subsection 3 Sentence 8 FSB (subject-specific provisions).

Referred to in LPO I (examination regulations for teaching-degree programmes)
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Module title
Game Research Lab - Architectures

Abbreviation
10-I=GRAR-182-m01

Module coordinator
holder of the Chair of Computer Science IX

Module offered by
Institute of Computer Science

ECTS
10

Method of grading
numerical grade

Duration
1 semester

Module level
graduate

Other prerequisites
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Contents
The Game Research Labs are project-oriented, master-level courses. In accordance with the definition of Games Engineering, they concern themselves with the effective provision and the systematic application of principles, methods and tools for the development and application of comprehensive software systems for computer games. There are four different directions of Game Research Labs: Theory, Applications, Design and Architecture. All of them implement a scientific process during which the students develop a project based on preceding works and a novel idea or hypothesis worthwhile exploring. Typical steps in a Game Research Lab include a short literature survey, the development of a concept, its realisation and evaluation. The "Game Research Lab - Architectures" is about Software Engineering perspectives in Games Engineering. Among those are the integration of different representations, models and calculi, their efficient and - at the same time - modular extensibility, maintenance and multi-faceted application. Accordingly, the subject of study of the course project can be existing design patterns in game engines, or the functional extension or overhaul of existing (sub-)engines. Next to the reflection and discussion of concrete architectures, efficiency can also be shown by means of performance analyses by profiling softwares. The resulting programming interfaces are another important field which is considered in the context of the "Game Research Lab - Architectures" course.

Intended learning outcomes
We recommend previous completion of basic courses in Games Engineering such as Game Labs II and III, complementing courses (e.g. Software Quality, Networked and Concurrent Programming) or advanced courses (e.g. Principles of Realtime Interactive Systems). The Game Research Labs empower the students to retrace current scientific works in great detail, to improve their research skills and to deepen their expertise with respect to specific challenges in Games Engineering. The "Game Research Lab - Architecture" instills knowledge and skills working with and on big software systems, innovating Software Engineering approaches and programming interfaces (e.g. domain-specific languages or visual programming) in Games Engineering contexts, and documenting their effectiveness.

Courses
(type, number of weekly contact hours, language — if other than German)
R (4)

Method of assessment
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
project report (10 to 15 pages) and presentation of project (15 to 30 minutes)
Language of assessment: German and/or English
creditable for bonus

Allocation of places
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Additional information
Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): GE. Cf. Section 3 Subsection 3 Sentence 8 FSB (subject-specific provisions).

Referred to in LPO I
( examination regulations for teaching-degree programmes)
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Module title | Abbreviation
---|---
Game Research Lab - Design | 10-I=GRDE-182-m01

Module coordinator | Module offered by
holder of the Chair of Computer Science IX | Institute of Computer Science

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The Game Research Labs are project-oriented, master-level courses. In accordance with the definition of Games Engineering, they concern themselves with the effective provision and the systematic application of principles, methods and tools for the development and application of comprehensive software systems for computer games. There are four different directions of Game Research Labs: Theory, Applications, Design and Architecture. All of them implement a scientific process during which the students develop a project based on preceding works and a novel idea or hypothesis worthwhile exploring. Typical steps in a Game Research Lab include a short literature survey, the development of a concept, its realisation and evaluation. The design of virtual worlds and games is the focus of the “Game Research Lab - Design”. It especially considers the design, import and presentation of complex and novel representations of computer graphics, haptics and audio, their (partially) automatic generation, the conceptualisation and implementation of virtual environments and levels, their presentation to the user/player as well as the design of user interfaces and innovative game mechanics.

Intended learning outcomes

We recommend previous completion of basic courses in Games Engineering such as Interactive Computer Graphics, Human-Computer Interaction, Asset Development or Game Development (corresponds with GameLab I). The Game Research Labs empower the students to retrace current scientific works in great detail, to improve their research skills and to deepen their expertise with respect to specific challenges in Games Engineering. In terms of contents, the "Game Research Lab - Applications" comprises knowledge and skills in the development life cycle of games, in the interdisciplinary discourse needed for applications in certain domains and in consideration of platform-specific programming requirements. Knowledge and skills regarding the design of virtual worlds and their presentation are the focus of the "Game Research Lab - Design". To this end, the students learn, for example, how to work with a great number of existing software solutions in the field of design, to understand and programmatically work with widely spread and highly specialised data forms, as well as to support the interaction and presentation of contents by means of Computer Science technologies.

Courses (type, number of weekly contact hours, language — if other than German)

R (4)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

project report (10 to 15 pages) and presentation of project (15 to 30 minutes)
Language of assessment: German and/or English
creditable for bonus

Allocation of places

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Additional information

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): GE. Cf. Section 3 Subsection 3 Sentence 8 FSB (subject-specific provisions).

Referred to in LPO I (examination regulations for teaching-degree programmes)

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### Game Research Lab - Applications

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The Game Research Labs are project-oriented, master-level courses. In accordance with the definition of Games Engineering, they concern themselves with the effective provision and the systematic application of principles, methods and tools for the development and application of comprehensive software systems for computer games. There are four different directions of Game Research Labs: Theory, Applications, Design and Architecture. All of them implement a scientific process during which the students develop a project based on preceding works and a novel idea or hypothesis worthwhile exploring. Typical steps in a Game Research Lab include a short literature survey, the development of a concept, its realisation and evaluation. The "Game Research Lab - Applications" aims at furthering or developing applications. While there are numerous viable application categories, entertainment and serious games are often considered first. Alternative categories of applications could, for instance, be remote control systems or social virtual worlds. These application categories, in turn, open up a vast space of application domains: Consider science, education and engineering. This Game Research Lab also includes developing for specific target platforms such as specialised video consoles.

### Intended learning outcomes

We recommend previous completion of basic courses in Games Engineering such as Interactive Computer Graphics, Human-Computer Interaction or Game Development (corresponds with GameLab I). The Game Research Labs empower the students to retrace current scientific works in great detail, to improve their research skills and to deepen their expertise with respect to specific challenges in Games Engineering. In terms of contents, the "Game Research Lab - Applications" comprises knowledge and skills in the development life cycle of games, in the interdisciplinary discourse needed for applications in certain domains and in consideration of platform-specific programming requirements.

### Courses

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### Method of assessment

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### Allocation of places

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### Additional information

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): GE. Cf. Section 3 Subsection 3 Sentence 8 FSB (subject-specific provisions).

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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### Contents
Completion of a practical task.

### Intended learning outcomes
The practical allows participants to work on a problem in algorithm and theory in teams.

### Courses
(type, number of weekly contact hours, language — if other than German)

| R  | 6   |

### Method of assessment
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

- Report (3 to 5 pages) and presentation of results (approx. 5 to 10 minutes)
- Language of assessment: German and/or English
- Creditable for bonus

### Allocation of places
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### Additional information
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): AT.

Referred to in LPO I (examination regulations for teaching-degree programmes)

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## Module Catalogue for the Subject
Computer Science
Master’s with 1 major, 120 ECTS credits

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### Module coordinator
Dean of Studies Informatik (Computer Science)

### Module offered by
Institute of Computer Science

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### Contents
Completion of a practical task.

### Intended learning outcomes
The practical allows participants to work on a problem in algorithm and theory in teams.

### Courses (type, number of weekly contact hours, language — if other than German)
R (6)

### Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
report (3 to 5 pages) and presentation of results (approx. 5 to 10 minutes)

Language of assessment: German and/or English

creditable for bonus

### Allocation of places
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### Additional information
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): AT.

Referred to in LPO I (examination regulations for teaching-degree programmes)

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**Contents**

Completion of a practical task.

**Intended learning outcomes**

The practical allows participants to work on a problem in software engineering in teams.

**Courses**

(type, number of weekly contact hours, language — if other than German)

R (6)

**Method of assessment**

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

report (3 to 5 pages) and presentation of results (approx. 5 to 10 minutes)

Language of assessment: German and/or English

creditable for bonus

**Allocation of places**

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**Additional information**

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): SE.

**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

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**Contents**
Completion of a practical task.

**Intended learning outcomes**
The practical allows participants to work on a problem in software engineering in teams.

**Courses** (type, number of weekly contact hours, language — if other than German)
R (6)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
report (3 to 5 pages) and presentation of results (approx. 5 to 10 minutes)
Language of assessment: German and/or English
creditable for bonus

**Allocation of places**
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**Additional information**
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): SE.

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Completion of a practical task.

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The practical allows participants to work on a problem in internet technology in teams.

**Courses** (type, number of weekly contact hours, language — if other than German)

R (6)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Report (3 to 5 pages) and presentation of results (approx. 5 to 10 minutes)
Language of assessment: German and/or English
Creditable for bonus

**Allocation of places**

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**Additional information**

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): IT.

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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- R (6)

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- creditable for bonus

**Allocation of places**

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**Additional information**

- Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): IT.
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**Contents**

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**Intended learning outcomes**

The practical allows participants to work on a problem in intelligent systems in teams.

**Courses** (type, number of weekly contact hours, language — if other than German)

R (6)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

report (3 to 5 pages) and presentation of results (approx. 5 to 10 minutes)

Language of assessment: German and/or English
creditable for bonus

**Allocation of places**

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**Additional information**

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**Contents**

Completion of a practical task.

**Intended learning outcomes**

The practical allows participants to work on a problem in intelligent systems in teams.

**Courses** (type, number of weekly contact hours, language — if other than German)

R (6)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Report (3 to 5 pages) and presentation of results (approx. 5 to 10 minutes)

Language of assessment: German and/or English

Creditable for bonus

**Allocation of places**

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**Additional information**

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): IS.

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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**Module coordinator**
Dean of Studies Informatik (Computer Science)

**Module offered by**
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<tbody>
<tr>
<td>1 semester</td>
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**Contents**
Completion of a practical task.

**Intended learning outcomes**
The practical allows participants to work on a problem in embedded systems in teams.

**Courses**
(type, number of weekly contact hours, language — if other than German)
R (6)

**Method of assessment**
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
report (3 to 5 pages) and presentation of results (approx. 5 to 10 minutes)
Language of assessment: German and/or English
creditable for bonus

**Allocation of places**
--

**Additional information**
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): ES.

**Referred to in LPO I**
(examination regulations for teaching-degree programmes)
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<table>
<thead>
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<th>Abbreviation</th>
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<tr>
<td>Practical Course - Embedded Systems 2</td>
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### Contents
Completion of a practical task.

### Intended learning outcomes
The practical allows participants to work on a problem in embedded systems in teams.

### Courses
(type, number of weekly contact hours, language — if other than German)

R (6)

### Method of assessment
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

report (3 to 5 pages) and presentation of results (approx. 5 to 10 minutes)
Language of assessment: German and/or English creditable for bonus

### Allocation of places
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### Additional information
Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): ES.

Referred to in LPO I (examination regulations for teaching-degree programmes)
--
Module title | Practical Course - Human Computer Interaction 1
---|---
Abbreviation | 10-I-PHCI1-182-m01

Module coordinator | Dean of Studies Informatik (Computer Science)
Module offered by | Institute of Computer Science

ECTS | 10
Method of grading | numerical grade
Only after succ. compl. of module(s) | --

Duration | 1 semester
Module level | undergraduate
Other prerequisites | --

Contents
Completion of a practical task.

Intended learning outcomes
The practical allows participants to work on a problem in human computer interactions in teams.

Courses (type, number of weekly contact hours, language — if other than German)
R (6)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
report (3 to 5 pages) and presentation of results (approx. 5 to 10 minutes)
Language of assessment: German and/or English
creditable for bonus

Allocation of places
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Additional information
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): HCI.
Referred to in LPO I (examination regulations for teaching-degree programmes)
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**Contents**

Completion of a practical task.

**Intended learning outcomes**

The practical allows participants to work on a problem in human computer interactions in teams.

**Courses** (type, number of weekly contact hours, language — if other than German)

R (6)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Report (3 to 5 pages) and presentation of results (approx. 5 to 10 minutes)

Language of assessment: German and/or English creditable for bonus

**Allocation of places**

--

**Additional information**

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): HCI.

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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<table>
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<tr>
<td>Selected Topics of Games Engineering</td>
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<tbody>
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**Contents**

Selected topics in algorithmics and theory.

**Intended learning outcomes**

The students understand the basic approach of games engineering. They are able to understand the solutions of complex problems in this area and apply them to similar questions.

**Courses** (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Written examination (approx. 60 to 120 minutes).

If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Language of assessment: German and/or English creditable for bonus

**Allocation of places**

--

**Additional information**

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): GE.

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

--
Module title: Selected Topics in Algorithms

Abbreviation: 10-I=AKA-161-m01

Module coordinator: holder of the Chair of Computer Science I

Module offered by: Institute of Computer Science

ECTS: 5

Method of grading: numerical grade

Only after succ. compl. of module(s): --

Duration: 1 semester

Module level: graduate

Other prerequisites: --

Contents:
Selected topics in algorithmics and theory.

Intended learning outcomes:
The students understand the basic approach of algorithmic computer science. They are able to understand the solutions of complex problems in this area and apply them to similar questions.

Courses:
(type, number of weekly contact hours, language — if other than German)
V (2) + Ü (2)

Method of assessment:
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English creditable for bonus

Allocation of places:
--

Additional information:
Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits):
AT

Referred to in LPO I (examination regulations for teaching-degree programmes)
--
Module title | Abbreviation
---|---
Selected Topics in Theory | 10-I=AKT-161-m01

Module coordinator | Module offered by
holder of the Chair of Computer Science I | Institute of Computer Science

ECTS | Method of grading | Only after succ. compl. of module(s)
5 | numerical grade | --

Duration | Module level | Other prerequisites
1 semester | graduate | --

Contents
Selected topics in algorithmics and theory.

Intended learning outcomes
The students understand the basic approach of theoretical computer science. They are able to understand the solutions of complex problems in this area and apply them to similar questions.

Courses (type, number of weekly contact hours, language — if other than German)
V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English creditable for bonus

Allocation of places
--

Additional information
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits):
AT

Referred to in LPO I (examination regulations for teaching-degree programmes)
--
## Module Catalogue for the Subject
**Computer Science**

**Master’s with 1 major, 120 ECTS credits**

<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>Selected Topics in Software Engineering</td>
<td>10-I=AKSE-161-m01</td>
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<th>Module coordinator</th>
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<tr>
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<tr>
<td>1 semester</td>
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</table>

### Contents
Selected topics in software engineering.

### Intended learning outcomes
The students possess an advanced knowledge about selected aspects of software engineering.

### Courses
(type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

### Method of assessment
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

- written examination (approx. 60 to 120 minutes).

If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Language of assessment: German and/or English creditable for bonus

### Allocation of places
--

### Additional information
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): SE.

**Referred to in LPO I**
(examination regulations for teaching-degree programmes)

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<table>
<thead>
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<th>Module title</th>
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<tbody>
<tr>
<td>Selected Topics in IT Security</td>
<td>10-I=AKITS-172-m01</td>
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<thead>
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<th>Module coordinator</th>
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<td>1 semester</td>
<td>graduate</td>
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</table>

**Contents**

Selected topics in IT security.

**Intended learning outcomes**

The students possess an advanced knowledge in the area of IT security. They are able to understand solutions to complex problems in this area and to transfer them to related questions.

**Courses** (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)  
Module taught in: English

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).  
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).  
Language of assessment: English  
creditable for bonus

**Allocation of places**

--

**Additional information**

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): SE, JS, LR, HCI, ES.

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

--
Selected Topics in Internet Technologies

Module Coordinator: holder of the Chair of Computer Science III
Module offered by: Institute of Computer Science

ECTS: 5
Method of grading: numerical grade
Only after succ. compl. of module(s): --
Duration: 1 semester
Module level: graduate
Other prerequisites: --

Contents
Selected topics in computer communication, for example design aspects of future internet structures: setup and control structures of the internet, multicast protocols, protocols for multimedia communication, optical networks, control mechanisms for redundant and real-time communication networks, p2p networks, ad-hoc networks, or -- new concepts and technologies in mobile communication: digital modulation, signal propagation, channel coding, modern transmission technologies (adaptive modulation and coding, hybrid ARQ, OFDM, MIMO), mac layer, mobileIP, routing in ad-hoc networks, vertical handover, UMTS IP multimedia subsystem, or -- planning and management methods in telecommunication networks: planning methods (forward engineering, reverse engineering), network management paradigms (central and decentral), framework for network management (IETF traffic engineering, ITU-T TMN, OSI management), planning and management methods (IP management mechanisms, network design, measurement, acquisition and evaluation of traffic and performance data, visualisation, result handling, simulation and analysis of networks), management tools, outlook and perspectives, or -- other current topics.

Intended learning outcomes
The students have a knowledge of advanced and current topics in the management and design of modern wired and wireless communication systems.

Courses
V (2) + Ü (2)

Method of assessment
written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English creditable for bonus

Allocation of places
--

Additional information
Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): IT.

Referred to in LPO I (examination regulations for teaching-degree programmes)
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<table>
<thead>
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<tr>
<td>Selected Topics in Intelligent Systems</td>
<td>10-I=AKIS-161-m01</td>
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### Module coordinator
holder of the Chair of Computer Science VI

### Module offered by
Institute of Computer Science

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### Contents
Selected topics in intelligent systems.

### Intended learning outcomes
The students possess an advanced knowledge in the area of intelligent systems. They are able to understand solutions to complex problems in this area and to transfer them to related questions.

### Courses
(type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

### Method of assessment
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Language of assessment: German and/or English creditable for bonus

### Allocation of places
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### Additional information
Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): IS.

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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<table>
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<td>Dean of Studies Informatik (Computer Science)</td>
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**Contents**

Selected topics in embedded systems.

**Intended learning outcomes**

The students possess specialised knowledge in the area of embedded systems. They are able to understand solutions to complex problems in this area and to transfer them to related questions.

**Courses** (type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Language of assessment: German and/or English creditable for bonus

**Allocation of places**

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**Additional information**

Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): ES.

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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</table>

**Contents**

Foundations in the following areas: definition of NLP and text mining, properties of text, sentence boundary detection, tokenisation, collocation, N-gram models, morphology, hidden Markov models for tagging, probabilistic parsing, word sense disambiguation, term extraction methods, information extraction, sentiment analysis.

The students possess theoretical and practical knowledge about typical methods and algorithms in the area of text mining and language processing mostly for English. They are able to solve problems through the methods taught. They have gained experience in the application of text mining algorithms.

**Intended learning outcomes**

The students possess theoretical and practical knowledge about typical methods and algorithms in the area of text mining and language processing. They are able to solve practical problems with the methods acquired in class. They have gained experience in the application of text mining algorithms.

**Courses**

(type, number of weekly contact hours, language — if other than German)

V (2) + Ü (2)

**Method of assessment**

(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

written examination (approx. 60 to 120 minutes).

If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).

Language of assessment: German and/or English

**Allocation of places**

--

**Additional information**

Focuses available for students of the Master’s programme Informatik (Computer Science, 120 ECTS credits): AT, IT, HCI.

**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

--
Module title: Selected Topics in Aerospace Engineering

Abbreviation: 10-I=AKLR-161-m01

Module coordinator: holder of the Chair of Computer Science VII

Module offered by: Institute of Computer Science

ECTS: 5

Method of grading: numerical grade

Only after succ. compl. of module(s): --

Duration: 1 semester

Module level: graduate

Other prerequisites: --

Contents:
Selected topics in aerospace engineering, for example: satellite communication, rocket science, propulsion systems, sensors and actuators for orientation control, perturbation of orbits, interplanetary orbits, rendezvous and docking, design of space ships, design of planetary bases, life support systems, special aspects of operations, payloads, optical systems, RADAR, earth monitoring, thermo management, structure of space ships, special areas of navigation, space environment, environment simulation, verification and test of space faring systems, space astronomy and planet missions, space medicine and biology, material science, quality management, space law, aeroflight topics, avionics for airplanes, air traffic control, areal navigation, pilot interfaces, air traffic control, air traffic management.

Intended learning outcomes:
The students possess an advanced knowledge about the respective topic of the selected area and are able to consider these foundations in their future plans of air or spaceborne systems.

Courses (type, number of weekly contact hours, language — if other than German):
V (2) + Ü (2)

Method of assessment (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus):
written examination (approx. 60 to 120 minutes).
If announced by the lecturer at the beginning of the course, the written examination may be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups of 2 candidates (approx. 15 minutes per candidate).
Separate written examination for Master's students.
Language of assessment: German and/or English creditable for bonus

Allocation of places:
--

Additional information:
Focuses available for students of the Master's programme Informatik (Computer Science, 120 ECTS credits): LR.

Referred to in LPO I (examination regulations for teaching-degree programmes):
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Thesis
(30 ECTS credits)
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**Contents**

Presentation and defence of the results of the Master's thesis in an open discussion.

**Intended learning outcomes**

The students are able to present the results of their Master's theses and defend them in a discussion.

**Courses** (type, number of weekly contact hours, language — if other than German)

K (0)

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

final colloquium (approx. 60 minutes)

Language of assessment: German and/or English

**Allocation of places**

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**Additional information**

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**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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<table>
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<td>Institute of Computer Science</td>
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**Contents**

Independent research and work on a topic of computer science that was agreed upon with a lecturer.

**Intended learning outcomes**

The student is able to independently research a given subject in computer science and use the knowledge and methods that they acquired in the master courses. They are able to present the result of their work in an acceptable manner.

**Courses** (type, number of weekly contact hours, language — if other than German)

No courses assigned to module

**Method of assessment** (type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)

Master's thesis (50 to 100 pages)
Language of assessment: German and/or English

**Allocation of places**

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**Additional information**

Time to complete: 6 months

**Referred to in LPO I** (examination regulations for teaching-degree programmes)

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