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

Examination regulations version: 2009
Responsible: Institute of Computer Science
# Contents

The subject is divided into

## Content and Objectives of the Programme

## Abbreviations used, Conventions, Notes, In accordance with

### Thesis

Bachelor Thesis Space- and Aerospace Computer Science

## Compulsory Courses

### Aerospace

- Introduction to Aerospace Systems
- Operations of Aerospace Systems
- Dynamics of aerospace systems
- On board data processing
- Measurement Technique

### Computer Science

- Practical Course in Programming
- Automation and Control Technology
- Algorithms and Data Structures for students of Space- and Aerospace Computer Science
- Core Avionics
- Practical Sensor and Control Systems Engineering

### Mathematics

- Mathematics 1 and 2 for students of Space- and Aerospace Computer Science

### Basics of Physics

- Introduction to Physics Part 1 for students of Physics Related Minor Subjects
- Introduction to Physics Part 2 for students of Physics Related Minor Subjects
- Practical Course A

## Compulsory Electives

- Ordinary Differential Equations
- Non-Linear Dynamics
- Numerical Mathematics 1
- Numerical Mathematics 2
- Software Technology
- Practical Course in Hardware
- Algorithmic Graph Theory
- Knowledge-based Systems
- Data Mining
- Object-oriented Programming
- Theory of Complexity
- Computer Architecture
- Computer Networks and Communication Systems
- Atmosphere and Space Physics
- Robotics
- Introduction to Control Theory
- Autonomous Systems
- Seminar Space Modelling
- Practical Course Part B (Aircraft and Spacecraft Informatics)
- Control Engineering

## Subject-specific Key Skills

- Databases
- Operating Systems
- Aerospace Laboratory
- Seminar for students of Space- and Aerospace Computer Science
- Excursion Space- and Aerospace
The subject is divided into

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<td>Subject-specific Key Skills</td>
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Content and Objectives of the Programme

The Bachelor of Science in aerospace computer science combining theoretical and practical elements is the first degree level offered by the Department of Mathematics and Computer Science at the Julius Maximilian University of Würzburg.

The aim of this degree is to teach students the most important aspects of computer science, to understand the theory of algorithms and their application, to improve analytical skills, the ability to think in abstract terms and to structure complex problems as well as basic skills and scientific aspects from aerospace technology, mathematics, physics, and astronomy.

This bachelor program focuses on:

1. Well established and fundamental knowledge of facts and methods as well as on the development of thought processes necessary for computer science,
2. Basic skills to understand, develop and program avionic systems for aerospace applications and
3. Basic knowledge about aerospace operations and orbit mechanics.

This programme covers the theoretical aspects as well as enough practical experience by concept building, constructing and programming such systems.
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:

ASPO2009

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

19-Jan-2011 (2011-6)

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.
Thesis

(12 ECTS credits)
<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>Bachelor Thesis Space- and Aerospace Computer Science</td>
<td>10-I-LRI-BA-092-m01</td>
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<table>
<thead>
<tr>
<th>Module coordinator</th>
<th>Module offered by</th>
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<tr>
<td>Dean of Studies Informatik (Computer Science)</td>
<td>Institute of Computer Science</td>
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<th>Module level</th>
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<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
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</table>

**Contents**

Researching and writing on a defined problem in aerospace information technology within a given time frame and adhering to the principles of good scientific practice.

**Intended learning outcomes**

The students are able to research and write on a defined problem in aerospace information technology, adhering to the principles of good scientific practice.

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

C (no information on SWS (weekly contact hours) and course language available)

**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 thesis
Language of assessment: German 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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Compulsory Courses

(129 ECTS credits)
Aerospace

(35 ECTS credits)
Module title: Introduction to Aerospace Systems
Abbreviation: 10-I-ELR-092-m01

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

ECTS: 6
Method of grading: numerical grade
Duration: 1 semester
Module level: undergraduate
Other prerequisites: By way of exception, additional prerequisites are listed in the section on assessments.

Contents
History of space flight, carrier rockets, orbits of spacecraft, environment conditions in space, special aspects of space applications, foundations of subsystems of spacecraft. Introduction to aviation systems, physical foundations of aircraft aerodynamics, flight stability, airplane technology and structure of aircraft, foundations of aviation propulsion and suitable material.

Intended learning outcomes
The students possess the theoretical and practical knowledge necessary to correctly classify aerospace systems, correctly identify the most important system relationships, formulate requirements for new systems and do calculations for selected basic system elements.

Courses
This module comprises 2 module components. Information on courses will be listed separately for each module component.
- 10-I-ELR-1-092: V + Ü (no information on SWS (weekly contact hours) and course language available)
- 10-I-ELR-2-092: V + Ü (no information on SWS (weekly contact hours) and course language available)

Method of assessment
Assessment in this module comprises the assessments in the individual module components as specified below. Unless stated otherwise, successful completion of the module will require successful completion of all individual assessments.

Assessment in module component 10-I-ELR-1-092: Introduction to Aerospace Systems 1
- 3 ECTS, Method of grading: numerical grade
- written examination (approx. 50 to 60 minutes); if announced by the lecturer by four weeks prior to the examination date, the written examination can be replaced by an oral examination of one candidate each or an oral examination in groups (one candidate each: 15 minutes, groups of 2: 20 minutes, groups of 3: 25 minutes)
- Other prerequisites: Admission prerequisite to assessment: exercises (type and scope to be announced by the lecturer at the beginning of the course).

Assessment in module component 10-I-ELR-2-092: Introduction to Aerospace Systems 2
- 3 ECTS, Method of grading: numerical grade
- written examination (approx. 50 to 60 minutes); if announced by the lecturer by four weeks prior to the examination date, the written examination can be replaced by an oral examination of one candidate each or an oral examination in groups (one candidate each: 15 minutes, groups of 2: 20 minutes, groups of 3: 25 minutes)
- Other prerequisites: Admission prerequisite to assessment: exercises (type and scope to be announced by the lecturer at the beginning of the course).

Allocation of places
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<tr>
<th>Additional information</th>
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<tr>
<td>Referred to in LPO 1</td>
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<tr>
<td>(examination regulations for teaching-degree programmes)</td>
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</table>
### Module title
Operations of Aerospace Systems

### Abbreviation
10-I-LRBE-092-m01

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

### Module offered by
Institute of Computer Science

### ECTS
9

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

### Numerical grade
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### Duration
1 semester

### Module level
undergraduate

### Other prerequisites
Admission prerequisite to assessment: exercises (type and scope to be announced by the lecturer at the beginning of the course).

### Contents
Basic functionalities and basic elements of the operation of air and space vehicles, ground station, structure of control centres, communication methods and systems, transmission path balance, transmission and operating standards, planning systems, operating procedures, flight manuals, telemetry and telecommando systems.

### Intended learning outcomes
The students possess the theoretical and practical knowledge necessary to correctly classify systems to operate systems in air and space vehicles, identify the most important system relationships, formulate requirements for new systems and develop the complete system as well as individual system elements for the operation of air and space vehicles in the ground segment.

### Courses
V + Ü (no information on SWS (weekly contact hours) and course language available)

### Method of assessment
written examination (approx. 80 to 90 minutes). If announced by the lecturer by four weeks prior to the examination date, the written examination can be replaced by an oral examination of one candidate each or an oral examination in groups. A 80 to 90 minute written examination is equivalent to a 20 minute (approx.) oral examination of one candidate each, a 30 minute (approx.) oral examination in groups of 2 and a 40 minute (approx.) oral examination in groups of 3.

### Allocation of places
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(examination regulations for teaching-degree programmes)
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<td>Institute of Computer Science</td>
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<tr>
<th>Duration</th>
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<th>Other prerequisites</th>
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<tr>
<td>1 semester</td>
<td>undergraduate</td>
<td>Admission prerequisite to assessment: exercises (type and scope to be announced by the lecturer at the beginning of the course).</td>
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</table>

**Contents**

Foundations of orbital dynamics and orientation dynamics of air and space vehicles, spherical trigonometry, two-body problem, identification of classical orbit elements from initial conditions, identification of orbit elements through observation (Laplace method), identification of orientation data, rocket lift-off trajectory.

**Intended learning outcomes**

Understanding of fundamental methods for acquisition, processing and control of orbit and orientation systems in air and space travel. Skills to apply the acquired knowledge in development and analysis of orbit and orientation systems.

**Courses**

<table>
<thead>
<tr>
<th>(type, number of weekly contact hours, language — if other than German)</th>
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<td>V + Ü (no information on SWS (weekly contact hours) and course language available)</td>
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**Method of assessment**

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<tr>
<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**

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<td>On board data processing</td>
<td>10-I-BDV-092-m01</td>
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**Module coordinator**
holder of the Chair of Computer Science VIII
Institute of Computer Science

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**Duration**
1 semester

**Module level**
undergraduate

**Other prerequisites**
Admission prerequisite to assessment: exercises (type and scope to be announced by the lecturer at the beginning of the course).

**Contents**
Tasks of onboard data handling systems (ODHS), components of ODHS, interfaces to other subsystems, division into hardware and software tasks, system architecture, topologies, reliable systems, fault tolerance, real-time programming, real-time operating systems, typical onboard software applications, implementing of example applications, hardware support.

**Intended learning outcomes**
The students understand what the tasks of ODHS are and how they are implemented. They understand the connections and dependencies with and from other subsystems. They are able to implement and control such systems themselves.

**Courses**
V + Ü (no information on SWS (weekly contact hours) and course language available)

**Method of assessment**
written examination (approx. 80 to 90 minutes). If announced by the lecturer by four weeks prior to the examination date, the written examination can be replaced by an oral examination of one candidate each or an oral examination in groups. A 80 to 90 minute written examination is equivalent to a 20 minute (approx.) oral examination of one candidate each, a 30 minute (approx.) oral examination in groups of 2 and a 40 minute (approx.) oral examination in groups of 3.

**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 Catalogue for the Subject
### Aerospace Computer Science
#### Bachelor's with 1 major, 180 ECTS credits

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<td>Measurement Technique</td>
<td>10-I-LMT-092-m01</td>
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<td>Dean of Studies Informatik (Computer Science)</td>
<td>Institute of Computer Science</td>
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<td>undergraduate</td>
<td>Admission prerequisite to assessment: exercises (type and scope to be announced by the lecturer at the beginning of the course).</td>
</tr>
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### Contents
- Definitions of terms, units of measurement, fundamental measurement techniques, sensitivity of analogue and digital measurement devices, measurement errors and measurement uncertainty, error kinds, error propagation, measurement uncertainty, measurement of electric values, voltage and current measurement, power measurement, resistance measurement (effective resistance and reactance), measurement bridge, influence of ground and stray capacitance, noise effects, dynamic behaviour of electrical systems, sensors and measurement techniques for: pressure, length, angle, temperature, sensors for optical measurements, force and acceleration, angular acceleration, measurement amplifier, measurement signal processing, AD-converter, digital measurements, frequency and time measurement, display of time dependence of electrical signals, computer-aided measurement recording, inertial navigation with inertial sensors, acceleration sensors, rotation (gyroscope), Coriolis angular sensor, position measurement using satellite navigation (GPS/GALILEO).

### Intended learning outcomes
The students master the fundamentals of measurement for aerospace systems and for applications in robotics and automation.

### Courses
- **V + Ü** (no information on SWS (weekly contact hours) and course language available)

### Method of assessment
- written examination (approx. 50 to 60 minutes); if announced by the lecturer by four weeks prior to the examination date, the written examination can be replaced by an oral examination of one candidate each or an oral examination in groups (one candidate each: 15 minutes, groups of 2: 20 minutes, groups of 3: 25 minutes)

### 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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Computer Science
(55 ECTS credits)
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<td>Practical Course in Programming</td>
<td>10-I-PP-102-m01</td>
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<td>1 semester</td>
<td>undergraduate</td>
<td>Admission prerequisite to assessment: exercises (type and scope to be announced by the lecturer at the beginning of the course).</td>
</tr>
</tbody>
</table>

**Contents**

The programming language Java. Independent creation of small to middle-sized, high-quality Java programs.

**Intended learning outcomes**

The students are able to independently develop small to middle-sized, high-quality Java programs.

**Courses**

P (no information on SWS (weekly contact hours) and course language available)

**Method of assessment**

written examination (approx. 80 to 90 minutes). If announced by the lecturer by four weeks prior to the examination date, the written examination can be replaced by an oral examination of one candidate each or an oral examination in groups. A 80 to 90 minute written examination is equivalent to a 20 minute (approx.) oral examination of one candidate each, a 30 minute (approx.) oral examination in groups of 2 and a 40 minute (approx.) oral examination in groups of 3.

**Allocation of places**

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**Additional information**

Additional information on module duration: 1 to 2 semesters.

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

§ 49 (1) 1. c) Informatik Praktische Softwareentwicklung
§ 69 (1) 1. d) Informatik Praktische Softwareentwicklung
Module title | Abbreviation
--- | ---
Information Transmission | 10-I-IÜ-102-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)
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10 | numerical grade | --

Duration | Module level | Other prerequisites
--- | --- | ---
1 semester | undergraduate | Admission prerequisite to assessment: exercises (type and scope to be announced by the lecturer at the beginning of the course).

Contents
Introduction to probability calculus, coding theory, coding for fault detection and fault correction, information theory, spectrum and Fourier transform, modulation technique, structure of digital transmission systems, introduction to the structure of computer networks, communication protocols.

Intended learning outcomes
The students possess a technical, theoretical and practical knowledge of the structure of systems for information transmission, a knowledge that is necessary to understand these systems.

Courses (type, number of weekly contact hours, language — if other than German)
V + Ü (no information on SWS (weekly contact hours) and course language available)

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. 80 to 90 minutes). If announced by the lecturer by four weeks prior to the examination date, the written examination can be replaced by an oral examination of one candidate each or an oral examination in groups. A 80 to 90 minute written examination is equivalent to a 20 minute (approx.) oral examination of one candidate each, a 30 minute (approx.) oral examination in groups of 2 and a 40 minute (approx.) oral examination in groups of 3.

Allocation of places
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Additional information
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Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 69 (1) 1. c) Informatik Technische Informatik
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<td>Automation and Control Technology</td>
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<td>1 semester</td>
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<td>Admission prerequisite to assessment: exercises (type and scope to be announced by the lecturer at the beginning of the course).</td>
</tr>
</tbody>
</table>

### Contents

Overview of automation systems, fundamental principles of control technology, Laplace transformation, transfer function, plant, controller types, basic feedback loop, fundamental principles of control engineering, automata, structure of Petri nets, Petri nets for automisation, machine-related structure of processing computation machines, communication between process computers and periphery devices, software for automation systems, process synchronisation, process communication, real-time operating systems, real-time planning.

### Intended learning outcomes

The students master the fundamentals of automation and control.

### Courses

<table>
<thead>
<tr>
<th>Type, number of weekly contact hours, language</th>
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### Method of assessment

written examination (approx. 80 to 90 minutes). If announced by the lecturer by four weeks prior to the examination date, the written examination can be replaced by an oral examination of one candidate each or an oral examination in groups. A 80 to 90 minute written examination is equivalent to a 20 minute (approx.) oral examination of one candidate each, a 30 minute (approx.) oral examination in groups of 2 and a 40 minute (approx.) oral examination in groups of 3.

Language of assessment: German, English if agreed upon with the examiner

### Allocation of places

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### Additional information

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### Referred to in LPO I

(examination regulations for teaching-degree programmes)
**Module title**
Algorithms and Data Structures for students of Space- and Aerospace Computer Science

**Abbreviation**
10-I-ADS-LRI-092-m01

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

**Module offered by**
Institute of Computer Science

**ECTS**
10

**Method of grading**
Only after succ. compl. of module(s)

**Duration**
1 semester

**Module level**
undergraduate

**Other prerequisites**
Admission prerequisite to assessment: exercises (type and scope to be announced by the lecturer at the beginning of the course).

**Contents**
Design and analysis of algorithms, recursion vs. iteration, sort and search methods, data structures, abstract data types, lists, trees, graphs, basic graph algorithms, programming in Java.

**Intended learning outcomes**
The students are able to independently design algorithms as well as to precisely describe and analyse them. The students are familiar with the basic paradigms of the design of algorithms and are able to apply them in practical programs. The students are able to estimate the run-time behaviour of algorithms and to prove their correctness.

**Courses**
V + Ü (no information on SWS (weekly contact hours) and course language available)

**Method of assessment**
written examination (approx. 80 to 90 minutes). If announced by the lecturer by four weeks prior to the examination date, the written examination can be replaced by an oral examination of one candidate each or an oral examination in groups. A 80 to 90 minute written examination is equivalent to a 20 minute (approx.) oral examination of one candidate each, a 30 minute (approx.) oral examination in groups of 2 and a 40 minute (approx.) oral examination in groups of 3.

**Allocation of places**
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**Additional information**
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**Referred to in LPO I**
(examination regulations for teaching-degree programmes)

--
Module title | Abbreviation
--- | ---
Core Avionics | 10-I-MEC-092-m01

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

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

Duration | Module level | Other prerequisites
--- | --- | ---
1 semester | undergraduate | Admission prerequisite to assessment: exercises (type and scope to be announced by the lecturer at the beginning of the course).

Contents

Fundamental principles of data processing, especially for aerospace applications. What is information? Guidance for reliable systems, analogue, digital, FPGAs, radiation effects, micro programming, CPUs, DMAs, memory, memory organisation, system architecture, input and output, sensors and actuators, energy systems, reliability, fault tolerance. Programming of embedded systems in C++.

Intended learning outcomes

Understanding of analogue and digital data processing in embedded systems. Structure of hardware and programming. Embedded programming in C++, knowledge about common sensors and actuators as well as input and output systems.

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

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. 80 to 90 minutes). If announced by the lecturer by four weeks prior to the examination date, the written examination can be replaced by an oral examination of one candidate each or an oral examination in groups. A 80 to 90 minute written examination is equivalent to a 20 minute (approx.) oral examination of one candidate each, a 30 minute (approx.) oral examination in groups of 2 and a 40 minute (approx.) oral examination in groups of 3.

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>
<thead>
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<td>Practical Sensor and Control Systems Engineering</td>
<td>10-I-HMR-092-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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<td>1 semester</td>
<td>undergraduate</td>
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</table>

**Contents**
Practical experiments of control aspects (hardware and software), for example implementation of linear and non-linear controllers in robotics or aerospace information technology.

**Intended learning outcomes**
Students understand closed loop systems and are able to implement and set controllers.

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

P (no information on SWS (weekly contact hours) and course language available)

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

oral examination in groups of 2 candidates (approx. 30 minutes) or in groups of 3 candidates (approx. 40 minutes)

**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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Mathematics
(20 ECTS credits)
Module title

Mathematics 1 and 2 for students of Space- and Aerospace Computer Science

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<td>10-M-LRI12-092-m01</td>
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Module coordinator

Dean of Studies Mathematik (Mathematics)

Module offered by

Institute of Mathematics

ECTS: 20

Method of grading: numerical grade

Only after succ. compl. of module(s)

Duration: 2 semester

Module level: undergraduate

Other prerequisites: By way of exception, additional prerequisites are listed in the section on assessments.

Contents

Basics on numbers and functions, sequences and series, elementary functions, differential and integral calculus in one variable, vector calculus, linear maps and systems of linear equations, matrix calculus, eigenvalue theory, differential and integral calculus in several variables, differential equations, Fourier analysis, integral theorems.

Intended learning outcomes

The student gets acquainted with fundamental concepts and methods of mathematics. He/She learns to apply these methods to problems in natural and engineering sciences, in particular in aerospace computer science, and is able to interpret the results.

Courses

This module comprises 2 module components. Information on courses will be listed separately for each module component.

- 10-M-LRI12-1-092: V + Ü (no information on SWS (weekly contact hours) and course language available)
- 10-M-LRI12-2-092: V + Ü (no information on SWS (weekly contact hours) and course language available)

Method of assessment

Assessment in this module comprises the assessments in the individual module components as specified below. Unless stated otherwise, successful completion of the module will require successful completion of all individual assessments.

Assessment in module component 10-M-LRI12-1-092: Mathematics 1 for students of Space- and Aerospace Computer Science

- 10 ECTS, Method of grading: (not) successfully completed
- written examination (approx. 90 to 120 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)
- Language of assessment: German, English if agreed upon with the examiner
- Other prerequisites: Registration for the exercise must be made via SB@home at the beginning of the course or as announced by the lecturer in accordance with the specified registration deadlines. Certain prerequisites must be met to qualify for admission to assessment (e.g. successful completion of a certain percentage of exercises). The lecturer will inform students about the respective details at the beginning of the course. Registration for the exercise will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew and have to register anew, too.

Assessment in module component 10-M-LRI12-2-092: Mathematics 2 for students of Space- and Aerospace Computer Science

- 10 ECTS, Method of grading: numerical grade
- written examination (approx. 90 to 120 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)
- Language of assessment: German, English if agreed upon with the examiner
- Other prerequisites: Registration for the exercise must be made via SB@home at the beginning of the course or as announced by the lecturer in accordance with the specified registration deadlines. Certain prerequisites must be met to qualify for admission to assessment (e.g., successful completion of a certain percentage of exercises). The lecturer will inform students about the respective details at the beginning of the course. Registration for the exercise will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew and have to register anew, too.

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Bachelor’s with 1 major Aerospace Computer Science (2009)
Basics of Physics
(19 ECTS credits)
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<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<td>Introduction to Physics Part 1 for students of Physics Related Minor Subjects</td>
<td>11-ENNF1-062-m01</td>
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<td>Managing Director of the Institute of Applied Physics</td>
<td>Faculty of Physics and Astronomy</td>
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<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
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</table>

**Contents**
Mechanics, vibration theory, thermodynamics.

**Intended learning outcomes**
The students have basic knowledge of physics for engineering students.

**Courses** (type, number of weekly contact hours, language — if other than German)
V + Ü (no information on SWS (weekly contact hours) and course language available)

**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. 120 minutes)

**Allocation of places**
Only as part of pool of general key skills (ASQ): 20 places. Places will be allocated by lot.

**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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<tr>
<td>Introduction to Physics Part 2 for students of Physics Related Minor Subjects</td>
<td>11-ENNF2-062-m01</td>
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</table>

Contents
Science of electricity, magnetism, optics, Atomic Physics.

Intended learning outcomes
The students have basic knowledge of physics for engineering students.

Courses
V + Ü (no information on SWS (weekly contact hours) and course language available)

Method of assessment
written examination (approx. 120 minutes)

Allocation of places
Only as part of pool of general key skills (ASQ): 20 places. Places will be allocated by lot.

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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<tr>
<td>Practical Course A</td>
<td>11-P-PA-092-m01</td>
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**Module coordinator**
Managing Director of the Institute of Applied Physics

**Module offered by**
Faculty of Physics and Astronomy

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**Duration**
1 semester

**Contents**
Physical laws of mechanics, thermodynamics, science of electricity, types of error, error approximation and propagation, graphs, linear regression, average values and standard deviation, distribution functions, significance tests, writing of lab reports and publications.

**Intended learning outcomes**
The students know and have mastered physical measuring methods and experimenting techniques. They are able to independently plan and conduct experiments, to cooperate with others, and to document the results in a measuring protocol. They are able to evaluate the measuring results on the basis of error propagation and of the principles of statistics and to draw, present and discuss the conclusions.

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

Auswertung von Messungen und Fehlerrechnung (Measurements and Data Analysis): V (1 weekly contact hour) + Ü (1 weekly contact hour), once a year (winter semester)
Beispiele aus Mechanik, Wärmelehre und Elektrik (Examples from Mechanics, Thermodynamics and Electricity, BAM): P (2 weekly contact hours)

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

This module has the following assessment components
1. Topics covered in lectures and exercises: written examination (approx. 120 minutes)
2. Lab course: a) Preparing, performing and evaluating the experiments will be considered successfully completed if a Testat (exam) is passed. b) Talk (with discussion) to test the students’ understanding of the physics-related contents of the course (approx. 30 minutes).

Successful completion of approx. 50% of practice work is a prerequisite for admission to assessment component 1.
To pass assessment component 2, students must pass both elements a) and b). Students will be offered one opportunity to retake element a) and/or element b).
Students must register for assessment components 1 and 2 online (details to be announced).

**Allocation of places**
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**Additional information**
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**Referred to in LPO I** (examination regulations for teaching-degree programmes)
§ 53 (1) 1. a) Physik Mechanik, Wärmelehre, Elektrizitätslehre, Optik, der speziellen Relativitätstheorie
§ 53 (1) 1. c) Physik physikalische Grundpraktika
§ 77 (1) 1. d) Physik "physikalische Praktika"
Compulsory Electives
(19 ECTS credits)
Module title | Abbreviation
---|---
Ordinary Differential Equations | 10-M-ODE-082-m01

Module coordinator | Module offered by
---|---
Dean of Studies Mathematik (Mathematics) | Institute of Mathematics

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</table>

Contents

Existence and uniqueness theorem, continuous dependance of solutions on initial values, systems of linear differential equations, matrix exponential series, linear differential equations of higher order.

Intended learning outcomes

The student is acquainted with the fundamental concepts and methods of the theory of ordinary differential equations. He/she is able to apply these methods to practical problems.

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

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. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)

Language of assessment: German, English if agreed upon with the examiner

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 | Abbreviation
---|---
Non-Linear Dynamics | 10-M-NLD-072-m01

Module coordinator | Module offered by
Dean of Studies Mathematik (Mathematics) | Institute of Mathematics

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Duration | Module level | Other prerequisites
1 semester | undergraduate | Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.

Contents
Basic notions in stability theory, Lyapunov theory, stable manifolds, periodic solutions including Poincare-Bendixson, chaotic dynamics; applications in physics and biology (e.g. Hamiltonian systems, Volterra-Lotka).

Intended learning outcomes
The student is acquainted with the fundamental concepts and results in non-linear dynamics and their proof methods. He/She is able to apply these methods to simple situations, e.g. in physics or biology.

Courses
V + Ü (no information on SWS (weekly contact hours) and course language available)

Method of assessment
written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)
Language of assessment: German, English if agreed upon with the examiner

Allocation of places
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Additional information
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Referred to in LPO I
§ 73 (1) 1. Mathematik Analysis
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<td>Numerical Mathematics 1</td>
<td>10-M-NM1-082-m01</td>
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<td>Dean of Studies Mathematik (Mathematics)</td>
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</table>

**Contents**

Solution of systems of linear equations and curve fitting problems, nonlinear equations and systems of equations, interpolation with polynomials, splines and trigonometric functions, numerical integration.

**Intended learning outcomes**

The student is acquainted with the fundamental concepts and methods in numerical mathematics, applies them to practical problems and knows about their typical fields of application.

**Courses**

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)

Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**

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**Additional information**

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**Referred to in LPO I**

(examination regulations for teaching-degree programmes)

§ 73 (1) 5. Mathematik Angewandte Mathematik
### Module Catalogue for the Subject Aerospace Computer Science

#### Bachelor's with 1 major, 180 ECTS credits

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<td>Numerical Mathematics 2</td>
<td>10-M-NM2-082-m01</td>
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<td>Dean of Studies Mathematik</td>
<td>Institute of Mathematics</td>
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</table>

### Contents

Solution methods and applications for eigenvalue problems, linear programming, initial value problems for ordinary differential equations, boundary value problems.

### Intended learning outcomes

The student is able to draw a distinction between the different concepts of numerical mathematics and knows about their advantages and limitations concerning the possibilities of application in different fields of natural and engineering sciences and economics.

### Courses

<table>
<thead>
<tr>
<th>type, number of weekly contact hours, language — if other than German</th>
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### Method of assessment

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<td>written examination (approx. 90 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)</td>
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Language of assessment: German, English if agreed upon with the examiner

### Allocation of places

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### Additional information

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

§ 73 (1) 5. Mathematik Angewandte Mathematik
### Module Catalogue for the Subject Aerospace Computer Science

**Bachelor’s with 1 major, 180 ECTS credits**

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<td>Dean of Studies Informatik (Computer Science)</td>
<td>Institute of Computer Science</td>
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<td>Admission prerequisite to assessment: exercises (type and scope to be announced by the lecturer at the beginning of the course).</td>
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</table>

### Contents

Object-oriented software development with UML, development of graphical user interfaces, foundations of databases and object-relational mapping, foundations of web programming (HTML, XML), software development processes, unified process, agile software development, project management, quality assurance.

### Intended learning outcomes

The students possess a fundamental theoretical and practical knowledge on the design and development of software systems.

### Courses

V + Ü (no information on SWS (weekly contact hours) and course language available)

### Method of assessment

written examination (approx. 80 to 90 minutes). If announced by the lecturer by four weeks prior to the examination date, the written examination can be replaced by an oral examination of one candidate each or an oral examination in groups. A 80 to 90 minute written examination is equivalent to a 20 minute (approx.) oral examination of one candidate each, a 30 minute (approx.) oral examination in groups of 2 and a 40 minute (approx.) oral examination in groups of 3.

### Allocation of places

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### Additional information

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

§ 49 (1) 1. b) Datenbanksysteme und Softwaretechnologie
§ 69 (1) 1. b) Datenbanksysteme und Softwaretechnologie
<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>Practical Course in Hardware</td>
<td>10-I-HWP-102-m01</td>
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**Module coordinator**  
Dean of Studies Informatik (Computer Science)

**Module offered by**  
Institute of Computer Science

<table>
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<th>ECTS</th>
<th>Method of grading</th>
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</tr>
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</tbody>
</table>

**Duration**  
1 semester

**Module level**  
undergraduate

**Other prerequisites**  
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**Contents**  
Practical experiments on hardware aspects, for example in communication technology, robots or the structure of a complete microprocessor.

**Intended learning outcomes**  
The students are able to independently review, prepare and perform experiments with the help of experiment descriptions, to independently search for additional information as well as to document and evaluate experiment results.

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

P (no information on SWS (weekly contact hours) and course language available)

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

completion of project assignments, presentation (type and expenditure of time to be specified by the lecturer at the beginning of the course)

**Allocation of places**  
--

**Additional information**  
--

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

--
Module Catalogue for the Subject
Aerospace Computer Science
Bachelor's with 1 major, 180 ECTS credits

<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>Algorithmic Graph Theory</td>
<td>10-I-GT-102-m01</td>
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<table>
<thead>
<tr>
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<th>Module offered by</th>
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<td>Dean of Studies Informatik (Computer Science)</td>
<td>Institute of Computer Science</td>
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<tr>
<th>Duration</th>
<th>Module level</th>
<th>Other prerequisites</th>
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</thead>
<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
<td>Admission prerequisite to assessment: exercises (type and scope to be announced by the lecturer at the beginning of the course).</td>
</tr>
</tbody>
</table>

**Contents**

We discuss typical graph problems: We solve round trip problems, calculate maximal flows, find matchings and colourings, work with planar graphs and find out how the ranking algorithm of Google works. Using the examples of graph problems, we also become familiar with new concepts, for example how we model problems as linear programs or how we show that they are fixed parameter computable.

**Intended learning outcomes**

The students are able to model typical problems in computer science as graph problems. In addition, the participants are able to decide which tool from the course helps solve a given graph problem algorithmically. In this course, students learn in detail how to estimate the run time of given graph algorithms.

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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. 50 to 60 minutes); if announced by the lecturer by four weeks prior to the examination date, the written examination can be replaced by an oral examination of one candidate each or an oral examination in groups (one candidate each: 15 minutes, groups of 2: 20 minutes, groups of 3: 25 minutes)

Language of assessment: German, English if agreed upon with the examiner

**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>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>Knowledge-based Systems</td>
<td>10-I-WBS-102-m01</td>
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<table>
<thead>
<tr>
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<tbody>
<tr>
<td>holder of the Chair of Computer Science VI</td>
<td>Institute of Computer Science</td>
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<tr>
<td>1 semester</td>
<td>undergraduate</td>
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</table>

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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. 50 to 60 minutes); if announced by the lecturer by four weeks prior to the examination date, the written examination can be replaced by an oral examination of one candidate each or an oral examination in groups (one candidate each: 15 minutes, groups of 2: 20 minutes, groups of 3: 25 minutes)

Language of assessment: German, English if agreed upon with the examiner

**Allocation of places**

--

**Additional information**

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

--
Module title | Abbreviation
---|---
Data Mining | 10-I-DM-102-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 | undergraduate | Admission prerequisite to assessment: exercises (type and scope to be announced by the lecturer at the beginning of the course).

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, other 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

<table>
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<th>(type, number of weekly contact hours, language — if other than German)</th>
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Method of assessment

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Allocation of places

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Additional information

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Referred to in LPO I

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<td>--</td>
</tr>
<tr>
<td>Module title</td>
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<td>--------------------------------</td>
</tr>
<tr>
<td>Object-oriented Programming</td>
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<table>
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<td>Dean of Studies Informatik (Computer Science)</td>
<td>Institute of Computer Science</td>
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<tr>
<th>Duration</th>
<th>Module level</th>
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<td>undergraduate</td>
<td>Admission prerequisite to assessment: exercises (type and scope to be announced by the lecturer at the beginning of the course).</td>
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</tbody>
</table>

**Contents**

Polymorphism, generic programming, meta programming, web programming, templates, document management.

**Intended learning outcomes**

The students are proficient in the different paradigms of object-oriented programming and have experience in their practical use.

**Courses**

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

V + Ü (no information on SWS (weekly contact hours) and course language available)

**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. 50 to 60 minutes); if announced by the lecturer by four weeks prior to the examination date, the written examination can be replaced by an oral examination of one candidate each or an oral examination in groups (one candidate each: 15 minutes, groups of 2: 20 minutes, groups of 3: 25 minutes)

Language of assessment: German, English if agreed upon with the examiner

**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>Theory of Complexity</td>
<td>10-I-KT-102-m01</td>
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<td>Institute of Computer Science</td>
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<td>Admission prerequisite to assessment: exercises (type and scope to be announced by the lecturer at the beginning of the course).</td>
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</table>

**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**

$V + Ü$ (no information on SWS (weekly contact hours) and course language available)

**Method of assessment**

written examination (approx. 50 to 60 minutes); if announced by the lecturer by four weeks prior to the examination date, the written examination can be replaced by an oral examination of one candidate each or an oral examination in groups (one candidate each: 15 minutes, groups of 2: 20 minutes, groups of 3: 25 minutes). Language of assessment: German, English if agreed upon with the examiner.

**Allocation of places**

--

**Additional information**

--

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

--
## Computer Architecture

**Abbreviation**

10-I-RAK-102-m01

**Module coordinator**

holder of the Chair of Computer Science V

**Module offered by**

Institute of Computer Science

<table>
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<th>ECTS</th>
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</table>

**Duration**

1 semester

**Module level**

undergraduate

**Other prerequisites**

Admission prerequisite to assessment: exercises (type and scope to be announced by the lecturer at the beginning of the course).

### 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

<table>
<thead>
<tr>
<th>(type, number of weekly contact hours, language — if other than German)</th>
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<tbody>
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### Method of assessment

- written examination (approx. 50 to 60 minutes); if announced by the lecturer by four weeks prior to the examination date, the written examination can be replaced by an oral examination of one candidate each or an oral examination in groups (one candidate each: 15 minutes, groups of 2: 20 minutes, groups of 3: 25 minutes)
- Language of assessment: German, English if agreed upon with the examiner

### Allocation of places

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### Additional information

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

§ 69 (1) 1. c) Informatik Technische Informatik
<table>
<thead>
<tr>
<th>Module title</th>
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<tbody>
<tr>
<td>Computer Networks and Communication Systems</td>
<td>10-I-RK-102-m01</td>
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<tbody>
<tr>
<td>holder of the Chair of Computer Science III</td>
<td>Institute of Computer Science</td>
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<td>Admission prerequisite to assessment: exercises (type and scope to be announced by the lecturer at the beginning of the course).</td>
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</table>

## 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

V + Ü (no information on SWS (weekly contact hours) and course language available)

## Method of assessment

written examination (approx. 80 to 90 minutes). If announced by the lecturer by four weeks prior to the examination date, the written examination can be replaced by an oral examination of one candidate each or an oral examination in groups. A 80 to 90 minute written examination is equivalent to a 20 minute (approx.) oral examination of one candidate each, a 30 minute (approx.) oral examination in groups of 2 and a 40 minute (approx.) oral examination in groups of 3.

Language of assessment: German, English if agreed upon with the examiner

## Allocation of places

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## Additional information

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## Referred to in LPO I

(examination regulations for teaching-degree programmes)

--
### Module Catalogue for the Subject
### Aerospace Computer Science
#### Bachelor's with 1 major, 180 ECTS credits

<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
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<tbody>
<tr>
<td>Atmosphere and Space Physics</td>
<td>11-AWP-092-m01</td>
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<tr>
<td>Managing Director of the Institute of Theoretical Physics and Astrophysics</td>
<td>Faculty of Physics and Astronomy</td>
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<td>Certain prerequisites must be met to qualify for admission to assessment. The lecturer will inform students about the respective details at the beginning of the course. Registration for the course will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.</td>
</tr>
</tbody>
</table>

### Contents


### Intended learning outcomes

The students have knowledge of the physics of planetary atmospheres, especially of the atmosphere of the Earth and near-Earth space. They are able to apply the acquired knowledge to the solution of problems of interplanetary space missions.

### Courses

R + V (no information on SWS (weekly contact hours) and course language available)

### Method of assessment

a) written examination (approx. 90 minutes) or b) oral examination of one candidate each or oral examination in groups (approx. 30 minutes per candidate) or c) project report (approx. 8 pages, time to complete: 1 to 4 weeks) or d) presentation/seminar presentation (approx. 30 minutes)

Assessment offered: When and how often assessment will be offered depends on the method of assessment and will be announced in due form under observance of Section 32 Subsection 3 ASPO (general academic and examination regulations) 2009.

Language of assessment: German 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)
Module title | Abbreviation
---|---
Robotics | 10-I=RO-102-m01

<table>
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<tr>
<td>holder of the Chair of Computer Science VII</td>
<td>Institute of Computer Science</td>
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<td>Where applicable, prerequisites as specified by the lecturer at the beginning of the course (e.g. completion of exercises).</td>
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<table>
<thead>
<tr>
<th>Duration</th>
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</thead>
<tbody>
<tr>
<td>1 semester</td>
<td>graduate</td>
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</table>

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, holonomes and non-holonomic 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 + Ü (no information on SWS (weekly contact hours) and course language available)

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. 80 to 90 minutes). If announced by the lecturer by four weeks prior to the examination date, the written examination can be replaced by an oral examination of one candidate each or an oral examination in groups. A 80 to 90 minute written examination is equivalent to a 20 minute (approx.) oral examination of one candidate each, a 30 minute (approx.) oral examination in groups of 2 and a 40 minute (approx.) oral examination in groups of 3.

Language of assessment: German, English if agreed upon with the examiner

Allocation of places

--

Additional information

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

--
### Module title

**Introduction to Control Theory**

| Abbreviation | 10-M-ARTH-102-m01 |

### Module coordinator

Dean of Studies Mathematik (Mathematics)

### Module offered by

Institute of Mathematics

<table>
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<tr>
<td>10</td>
<td>numerical grade</td>
<td>Only after succ. compl. of module(s)</td>
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</table>

### Duration

1 semester

### Module level

graduate

### Registration for the exercise

Registration for the exercise must be made via SB@home at the beginning of the course or as announced by the lecturer in accordance with the specified registration deadlines. Certain prerequisites must be met to qualify for admission to assessment (e.g., successful completion of a certain percentage of exercises). The lecturer will inform students about the respective details at the beginning of the course. Registration for the exercise will be considered a declaration of will to seek admission to assessment. If students have obtained the qualification for admission to assessment over the course of the semester, the lecturer will put their registration for assessment into effect. Students who meet all prerequisites will be admitted to assessment in the current or in the subsequent semester. For assessment at a later date, students will have to obtain the qualification for admission to assessment anew.

### Contents

Introduction to mathematical systems theory: stability, controllability and observability, state feedback and stability, basics in optimal control.

### Intended learning outcomes

The student is acquainted with the fundamental notions and methods of control theory. He/She is able to establish a connection between these results and broader theories, and learns about the interactions of geometry and other fields of mathematics.

### Courses

V + Ü (no information on SWS (weekly contact hours) and course language available)

### Method of assessment

written examination (approx. 90 to 120 minutes); if announced by the lecturer, the written examination can be replaced by an oral examination of one candidate each (approx. 20 minutes) or an oral examination in groups (groups of 2, approx. 30 minutes)

Assessment offered: Assessment offered in the semester in which the course is offered and in the subsequent semester, course offered on demand or every four semesters.

Language of assessment: German 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>
<thead>
<tr>
<th>Module title</th>
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<tbody>
<tr>
<td>Autonomous Systems</td>
<td>10-I-ASY-092-m01</td>
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**Module coordinator**
Dean of Studies Informatik (Computer Science)

**Module offered by**
Institute of Computer Science

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</table>

**Contents**
This course teaches the foundations of autonomous systems.

**Intended learning outcomes**
The students master the fundamentals of autonomous systems.

**Courses**
V + Ü (no information on SWS (weekly contact hours) and course language available)

**Method of assessment**
written examination (approx. 50 to 60 minutes); if announced by the lecturer by four weeks prior to the examination date, the written examination can be replaced by an oral examination of one candidate each or an oral examination in groups (one candidate each: 15 minutes, groups of 2: 20 minutes, groups of 3: 25 minutes)

Assessment offered: once a year

**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>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seminar Space Modelling</td>
<td>10-I-SRM-092-m01</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Module coordinator</th>
<th>Module offered by</th>
</tr>
</thead>
<tbody>
<tr>
<td>holder of the Chair of Computer Science VII</td>
<td>Institute of Computer Science</td>
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</table>

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<th>ECTS</th>
<th>Method of grading</th>
<th>Only after succ. compl. of module(s)</th>
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<tbody>
<tr>
<td>5</td>
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<table>
<thead>
<tr>
<th>Duration</th>
<th>Module level</th>
<th>Other prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
<td>--</td>
</tr>
</tbody>
</table>

**Contents**

Independent review of a current topic in aerospace information technology based on literature and, if applicable, software with written and oral presentation or video.

**Intended learning outcomes**

The students are able to independently review a current topic in aerospace information technology, 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 (no information on SWS (weekly contact hours) and course language available)

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

Talk (approx. 30 to 45 minutes) and written elaboration (approx. 5 to 10 pages)

**Allocation of places**

--

**Additional information**

--

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

--
## Module Catalogue for the Subject
### Aerospace Computer Science
Bachelor's with 1 major, 180 ECTS credits

<table>
<thead>
<tr>
<th>Module title</th>
<th>Abbreviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Practical Course Part B (Aircraft and Spacecraft Informatics)</td>
<td>11-P-PB-LR-092-m01</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Module coordinator</th>
<th>Module offered by</th>
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<tbody>
<tr>
<td>Managing Director of the Institute of Applied Physics</td>
<td>Faculty of Physics and Astronomy</td>
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<tbody>
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<td>11-P-PA</td>
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<tr>
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</thead>
<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
<td>--</td>
</tr>
</tbody>
</table>

### Contents
Physical laws of mechanics, thermodynamics, optics, science of electricity, vibration and waves, Atomic and Nuclear Physics, wave optics. Basic measuring methods using computers and storage oscilloscopes.

### Intended learning outcomes
The students have knowledge and skills of physical measuring instruments and experimental techniques. They are able to independently plan and conduct experiments in cooperation with others, and to document the results in a measurement protocol.

### Courses
(type, number of weekly contact hours, language — if other than German)
- Klassische Physik (Classical Physics, KLP): P (2 weekly contact hours)
- Elektrizitätslehre und Schaltungen (Electricity and Circuits, ELS): P (2 weekly contact hours)
- Wellenoptik (Physical Optics, WOP): P (2 weekly contact hours)
- Atom- und Kernphysik (Atomic and Nuclear Physics, AKP): P (2 weekly contact hours)
- Computer und Messtechnik (Computers and Measurement Technology, CMT): P (2 weekly contact hours)

<table>
<thead>
<tr>
<th>Method of assessment</th>
<th>(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)</th>
</tr>
</thead>
<tbody>
<tr>
<td>This module has the following assessment components</td>
<td></td>
</tr>
<tr>
<td>1. Lab course in part 1: a) Preparing, performing and evaluating the experiments will be considered successfully completed if a Testat (exam) is passed. b) Talk (with discussion) to test the students' understanding of the physics-related contents of the course (approx. 30 minutes).</td>
<td></td>
</tr>
<tr>
<td>2. Lab course in part 2: a) Preparing, performing and evaluating the experiments will be considered successfully completed if a Testat (exam) is passed. b) Talk (with discussion) to test the students' understanding of the physics-related contents of the course (approx. 30 minutes).</td>
<td></td>
</tr>
</tbody>
</table>

Students must register for assessment components 1 and 2 online (registration deadline to be announced). Students will be offered one opportunity to retake element a) and/or element b). To pass an assessment component, they must pass both elements a) and b).

To pass this module, students must successfully complete two out of the five courses.

To pass this module, students must pass both assessment component 1 and assessment component 2.

### Allocation of places
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### Additional information
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### Referred to in LPO I (examination regulations for teaching-degree programmes)
- § 53 (1) 1. a) Physik Mechanik, Wärmelehre, Elektrizitätslehre, Optik, der speziellen Relativitätstheorie
- § 53 (1) 1. b) Physik Aufbau der Materie
- § 53 (1) 1. c) Physik physikalische Grundpraktika
- § 77 (1) 1. b) Physik "Fortgeschrittene Experimentalphysik"
- § 77 (1) 1. d) Physik "physikalische Praktika"
### Module title

Control Engineering

### Abbreviation

10-I-STE-092-m01

<table>
<thead>
<tr>
<th>ECTS</th>
<th>Method of grading</th>
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<table>
<thead>
<tr>
<th>Duration</th>
<th>Module level</th>
<th>Other prerequisites</th>
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</thead>
<tbody>
<tr>
<td>1 semester</td>
<td>undergraduate</td>
<td>Academic requirements to be met in exercises. Type and scope to be announced by the lecturer at the beginning of the course.</td>
</tr>
</tbody>
</table>

### Contents

The module teaches the foundations of control technology.

### Intended learning outcomes

The students master the fundamentals of control technology.

### Courses

V + Ü (no information on SWS (weekly contact hours) and course language available)

### Method of assessment

(If announced by the lecturer by four weeks prior to the examination date, the written examination can be replaced by an oral examination of one candidate each or an oral examination in groups (one candidate each: 15 minutes, groups of 2: 20 minutes, groups of 3: 25 minutes)

Assessment offered: once a year

### Allocation of places

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### Additional information

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### Referred to in LPO I

(examination regulations for teaching-degree programmes)

--
Subject-specific Key Skills

(15-17 ECTS credits)
Module title
Databases

Abbreviation
10-I-DB-102-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
undergraduate

Other prerequisites
Admission prerequisite to assessment: exercises (type and scope to be announced by the lecturer at the beginning of the course).

Contents
Relational algebra and complex SQL statements; database planning and normal forms; transaction management.

Intended learning outcomes
The students possess knowledge about database modelling and queries in SQL as well as transactions.

Courses (type, number of weekly contact hours, language — if other than German)
V + Ü (no information on SWS (weekly contact hours) and course language available)

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. 50 to 60 minutes); if announced by the lecturer by four weeks prior to the examination date, the written examination can be replaced by an oral examination of one candidate each or an oral examination in groups (one candidate each: 15 minutes, groups of 2: 20 minutes, groups of 3: 25 minutes)
Language of assessment: German, English if agreed upon with the examiner

Allocation of places
-

Additional information
-

Referred to in LPO I (examination regulations for teaching-degree programmes)
§ 49 (1) 1. b) Datenbanksysteme und Softwaretechnologie
§ 69 (1) 1. b) Datenbanksysteme und Softwaretechnologie
### Module Title
Operating Systems

### Abbreviation
10-I-BS-102-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
undergraduate

### Other Prerequisites
Admission prerequisite to assessment: exercises (type and scope to be announced by the lecturer at the beginning of the course).

### 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
V + Ü (no information on SWS (weekly contact hours) and course language available)

### 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. 50 to 60 minutes); if announced by the lecturer by four weeks prior to the examination date, the written examination can be replaced by an oral examination of one candidate each or an oral examination in groups (one candidate each: 15 minutes, groups of 2: 20 minutes, groups of 3: 25 minutes)

Language of assessment: German, English if agreed upon with the examiner

### Allocation of Places
--

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

§ 69 (1) 1. c) Informatik Technische Informatik
Module title | Abbreviation
---|---
Aerospace Laboratory | 10-I-LRLA-092-m01

Module coordinator
holder of the Chair of Computer Science VIII

Module offered by
Institute of Computer Science

<table>
<thead>
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Contents
Structure and control of satellites and airplanes, control and (very little) regulation of physical/mechanical systems, sensors and actuators, energy, structure (construction) of a satellite model/simulator, construction of a ground segment for different components and systems of air and space flight, structure of simplified subsystems of air and space flight. Life cycle of a complex development consisting of software, hardware, electronics and mechanics. Selection of suitable components.

Intended learning outcomes
The students will be able to construct and integrate prototypical subsystems consisting of software, hardware, electronics and mechanics by themselves as well as to operate, test and document these. The whole life cycle of a development will be tested: capture of requirements, rudimentary design, detailed design, modelling, implementation (software, hardware, mechanics), test design, inspection, maintenance, transfer to the successor model.

Courses
V + Ü (no information on SWS (weekly contact hours) and course language available)

Method of assessment
practical exercises (time to complete: approx. 6 weeks) and documentation (approx. 10 pages)

Allocation of places
--

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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<tbody>
<tr>
<td>Seminar for students of Space- and Aerospace Computer Science</td>
<td>10-I-LRS-092-m01</td>
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**Module coordinator**
holder of the Chair of Computer Science VII

**Module offered by**
Institute of Computer Science

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**Duration**
1 semester

**Module level**
undergraduate

**Other prerequisites**
--

**Contents**
Independent review of a current topic in aerospace information technology on the basis of literature and, if applicable, software with written and oral presentation.

**Intended learning outcomes**
The students are able to independently review a current topic in aerospace information technology, 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 (no information on SWS (weekly contact hours) and course language available)

**Method of assessment**
(type, scope, language — if other than German, examination offered — if not every semester, information on whether module is creditable for bonus)
talk (approx. 30 to 45 minutes) and written elaboration (approx. 5 to 10 pages)

**Allocation of places**
--

**Additional information**
--

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

**Excursion Space- and Aerospace**

| Abbreviation | 10-I-LREX-092-m01 |

### Module coordinator

Dean of Studies Informatik (Computer Science)

### Module offered by

Institute of Computer Science

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### Contents

This module includes a field trip in the area of aerospace information technology.

### Intended learning outcomes

The students become familiar with practical aspects of aerospace engineering.

### Courses

E (no information on SWS (weekly contact hours) and course language available)

### Method of assessment

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

field trip log (approx. 2 pages)

### 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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