Module Handbook

Programme
Applied computer science and infotronic (Bachelor)

Faculty
Faculty of Electrical Engineering, Media Technology and Computer Science

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Fehler! Textmarke nicht definiert.
Module: Mathematics

Module number O-01
Module responsible Prof. Dr. Gerald Kupris
Course specialization
Course number and course name
O1101 Mathematics 1
O2101 Mathematics 2
Lecturer Prof. Dr. Gerald Kupris
Semester 1, 2
Length of the Module 2 Semesters
Module frequency
Course type Mandatory
SWS 13.0
ECTS 13.0
Workload Total: 0.0 hours
Teaching-/Course language German

Module’s objectives
The students should be able to apply during the studies mathematical concepts and methods for technical tasks and for working purposes.
The students will gain the following competencies: Dominate symbolic fractions (extend, shorten, exclude,...).
Solve, by means of vectors, basic geometrical tasks such as the following: distance from point-line, point-plane, straight-straight and angle of intersection of a straight-line with another straight line.

Manage to calculate complex numbers; especially by dominating calculations in different representations (Cartesian, polar, exponential). This way you will be able to apply the complex AC circuit analysis.
You should know about elementary function definitions, domain, range, special function values, important calculation rules and differentials. Particularly you should be able to draw graphics. You know about derivatives and its physical, geometrical and analytical meanings. You know about Defereential rules and know how to use it in expressions that are built from elementary functions.
You know about basic integrals and are able to apply the integration by substitution and partial integrate to simple cases.
You are able to apply integral calculations on geometrical or physical questions.
You can research linear systems of equation with the help of the Gaussian elimination method.
You are able to apply matrix calculus.
You can apply the differential and integral calculations to spatial curves, surfaces and areas. Particularly you are able to determine tangents and tangents’ plane.
You know the definition of Gradient, Divergence and rotation and their geometrical and physical meaning.
The students should be able to apply mathematical methods and concepts to technical tasks, during their studies and work.
In order to achieve this, the students will acquire the following skills:
Analysis and synthesis of periodic functions by Fourier series.
Solution of differential equations in first and second order.
Application of the Laplace Transformation on technical tasks.
Application of the Fourier-Transformation.
Basic understanding of the possibilities and the use of MATLAB.

O1101 Mathematics 1

Objectives
The students should be able to apply mathematical methods and concepts to technical tasks, during their studies and work.
In order to achieve this, the students will acquire the following skills:
Dominate symbolic fractions (extend, shorten, exclude...).
Solve, by means of vectors, basic geometrical tasks such as the following: distance from point-line, point-plane, straight-straight and angle of intersection of a straight-line with another straight line.
Manage to calculate complex numbers; especially by dominating calculations in different representations (Cartesian, polar, exponential). Through this you will be able to apply the complex AC circuit analysis.
You know about elementary function definitions, domain, range, special function values, important calculation rules and differentials. Particularly you should be able to draw graphics. You know about derivatives and its physical, geometrical and analytical meanings. You know about Derivative rules and know how to use it in expressions that are built from elementary functions.
You know about basic integrals and are able to apply the integration by substitution and partial integrate to simple cases. You are able to apply integral calculations on geometrical or physical questions. You can research linear systems of equation with the help of the Gaussian elimination method. You are able to apply matrix calculus. You can apply the Differential and integral calculations to spatial curves, surfaces and areas. Particularly you are able to determine tangents and tangents’ plane. You know the definition of Gradient, Divergence and rotation and their geometrical and physical meaning.

Content
Chapter 1. Numbers and Vectors
- Quantities and Illustrations
- The real numbers
- Planes
- Vectors
- Products
- Lines and Planes
- Complex numbers
Chapter 2. Functions, Limits. Steadiness
- Functions (Main Concepts)
- Polynomials and rational functions
- The circular functions
- Cipher and limits
- Calculation rules for Limits and convergence criteria
- Function limits, Steadiness

Chapter 3. Differentiation
- The derivations of a differential function
- Application of differentials
- Inverses
- The exponential and logarithmic functions

Chapter 4. Integration
- The certain integral
- Integration rules
- The integration of rational functions
- Improper Integrals

Chapter 5. Linear Algebra
- Linear Systems of equations and matrices
- The matrix multiplication
- Determinants

Types of tests
oral exam, written exam 90 minutes

Methods
Seminars

Literature
Jürgen Koch, Martin Stämpfle: Mathematik für das Ingenieurstudium, Hanser Verlag, München, 2010
Lothar Papula: Mathematik für Ingenieure und Naturwissenschaftler, Vieweg+Teubner Verlag, 2009
Thomas Rießinger: Mathematik für Ingenieure, Springer Verlag, Berlin 2009
Kurt Meyberg, Peter Vachenauer: Höhere Mathematik 1, Springer Verlag 2003

O2101 Mathematics 2

Objectives
The students should be able to apply mathematical methods and concepts to technical tasks, during their studies and work.
In order to achieve this, the students will acquire the following skills:
Analysis and synthesis of periodic functions by Fourier series
Solution of differential equations in first and second order
Application of the Laplace Transformation on technical tasks
Application of the Fourier-Transformation
Basic understanding of the possibilities and the use of MATLAB

Content
Periodic Functions and Fourier series
Differential equations
Laplace-Transformation
Fourier-Transformation
Introduction in MATLAB

Test types
Written exam, 90 Min.

Methods
Seminars

Literature
Jürgen Koch, Martin Stämpfle: Mathematik für das Ingenieurstudium, Hanser Verlag, München, 2010
Lothar Papula: Mathematik für Ingenieure und Naturwissenschaftler, Vieweg+Teubner Verlag, 2009
Thomas Rießinger: Mathematik für Ingenieure, Springer Verlag, Berlin 2009
Kurt Meyberg, Peter Vachenauer: Höhere Mathematik 1, Springer Verlag 2003
Module: Physics

Module number O-02
Module responsible Prof. Dr. Gerald Kupris
Course specialization
Course number and course name
O1102 Physics
Semester 1
Length of the Module 1 Semester
Module frequency
Course type Mandatory
Level
SWS 4.0
ECTS 5.0
Workload Total: 0.0 hours
Teaching-/Course language German

Modules’ objective
Develop understanding of physical relationships: mathematical modelling of physical phenomena; learn about basic physical concepts and laws and how to apply them; Solve physical problems; Conduct and evaluate experiments.

Access or recommended requirements
Basic knowledge of differential, integral and vector calculus

Content
Introduction of physical methods
Mechanics (kinematics and dynamics of particles)
Vibration and Waves
Electrical
Solid state physics

Teaching and learning
Classes
Seminars
Tutorials

Literature
Paul A. Tipler, Gene Mosca: Physik für Wissenschaftler und Ingenieure, Spektrum Akademischer Verlag, August 2009
O1102 Physics

Objectives
The students should be able to apply physical methods and concepts to technical tasks, during their studies and work.
In order to achieve this, the students will acquire the following skills:
Knowledge about physical quantities and their measurement
Basic knowledge in mechanics, Vibration theory and electrodynamics.

Content
Measurement and Units
dimensional motion
Movement in two and three dimensions
The Newtonian axioms
Work and und kinetic energy
Energy conservation
Momentum
Circular motion
Angular momentum
Vibration and Waves
Superposition and standing waves
The electric field
The electric potential
Capacity
Electricity
Magnetism and electricity
Effect and sources of the magnetic field
Magnetic river
Magnetic induction
Electromagnetic waves, Mobiles
Atoms, molecules and solids
Electric line: conductor, dielectric, semiconductors

Test Types
Written exam, 90 Min.

Methods
Seminars

Literature
Paul A. Tipler, Gene Mosca: Physik für Wissenschaftler und Ingenieure,
Spektrum Akademischer Verlag, August 2009
## Module: Fundamentals of electrical engineering

**Module number** O-03  
**Module responsible** Prof. Dr. Robert Bösnecker  
**Course specialization**  
**Course number and course name** O1103 Basics of electrical engineering  
**Semester** 1  
**Length of the Module** 1 Semester  
**Module frequency**  
**Course type** Mandatory  
**Level**  
**SWS** 6.0  
**ECTS** 7.0  
**Workload**  
- Attending time: 90.0 hours  
- Independent study: 120.0 hours  
- Total: 210.0 hours  
**Teaching-/Course language** German  

## Content  
DC Teaching  
- Electric charge and current density  
- Electric potential and voltage  
- Ohm's Law  
- Specifically Resistivity and conductivity  
- Temperature dependence from electrical  
- Resistance types  
- Electrical work/energy  
- Electrical power and efficiency  
- relationally & Arrow systems  
- Kirchhoff's laws  
- Ideal and linear electrical sources  
- Series Connection  
- Parallel connection  
- Delta-Start transformation  
- Network calculation  
- Superposition theorem  
- Equivalent voltage source  
- Alternating electricity theory  
- Periodic conditions  
- Sinusoidal sizes  
- Cursors  
- Complex calculations  
- Performance and energy
passive equivalent circuits
Series connection of R,L,C
Parallel-circuit von R,L,C
Branched circuits
Networks and transformations
Simple RC-filter
Transfer functions

O1103 Fundamentals of electrical engineering

Test type
Written exam, 90 Min.
Module: Fundamentals of Computer science

Module number O-04
Module responsible Prof. Dr. Peter Jüttner
Course specialization

Course number and course name O1104 Fundamentals of Computer science
O1105 Introduction to Programing
Semester 1
Length of the Module 1 Semester
Module frequency
Course type Mandatory
SWS 8.0
ECTS 10.0
Workload Total: 0.0 hours
Teaching-/Course language German

Modules’ objective
- Knowledge and understanding of computer science, its concepts and methods
- The ability to understand these basic principles and to apply them on examples

O1104 Fundamentals of computer science

Objectives
- Knowledge and understanding of computer science, its concepts and methods
- The ability to understand these basic principles and to apply them on examples

Content
- IT Definition
- IT working fields
- Information and messages
- Number systems
- Encodings
- Computer architectures
- Operating systems
- Propositional logic
- Predicate logic
- Machines’ state
- Modularization of programs
**Access- recommended requirements**  
- none

**Test type**  
Written exam, 90 Min.

**Methods**  
Seminars and practical exercises, partly group work

**Literature**  
- Andrew S. Tanenbaum and James Goodman:  
Computerarchitektur. Strukturen, Konzepte, Grundlagen. Pearson, 2001  
- Rolf Socher: Theoretische Grundlagen der Informatik. Fachbuchverlag Leipzig, 2005

**O1105 Introduction to programing**

**Objectives**  
- Knowledge and understanding of IT basics, its concepts and methods  
- The ability to understand this basic principles and to apply them on examples

**Content**  
- "Program" und "Programing" concepts  
- Definition and characteristics of Programing language and compilers  
- History of the Programing language C  
- Main structure and elements of C Programs  
  - main  
  - Variable  
  - Constant  
  - Data types  
  - Input and Outputs  
  - Operators  
  - Control Structure  
  - Vectors  
  - Pointer  
  - Functions and procedures

**Access- recommended requirements**  
none

**Test Types**  
Written exam, 90 Min

**Methods**  
Seminars and practical exercises, partly group work
**Literature**
- Helmut Erlenkötter: C Programmieren von Anfang an. rororo Verlag, 2009
- Brian Kernighan, Dennis Ritchie: Programmieren in C. Hanser Verlag, 1990
Module: Fundamentals of Sensor Systems

Module number  O-05  
Module responsible  Prof. Dr. Martin Jogwich  
Course specialization  
Course number and course name  O2102 Fundamentals of Sensor Systems  
Semester  2  
Length of the Module  1 Semester  
Module Frequency  
Course type  Mandatory  
Level  To be clarified by the studies director  
SWS  4.0  
ECTS  5.0  
Workload  Total: 0.0 hours  
Teaching-/Course language  German  

O2102 Fundamentals of Sensor Systems

Objectives
Understanding physical and technical basics about the general functions and principles of different sensors.

Content
Sensor principles of mechanics  
Sensor principles of thermodynamics  
Sensor principles of electrostatics and dynamics  
Sensor principles of propagation of electromagnetic waves and optics  

Test Types
Written exam of 90 Min.

Methods
Seminars
Module: Object-Oriented Programming

Module number                O-06
Module responsible           Prof. Dr. Peter Jüttner
Course specialization
Course number and course name O2103 Object-Oriented Programming
Semester                     2
Length of the Module         1 Semester
Module frequency
Course type                   Mandatory
SWS                          4.0
ECTS                         5.0
Workload                     Total: 0.0 hours
Teaching-/Course language    German

Objectives
- Knowledge and understanding about object-oriented programming and its concepts and methods
- Comprehensive knowledge of programming C++
- The ability to apply independently this knowledge when creating smaller Programs C++

O2103 Object-Oriented Programming

Objectives
- Knowledge and understanding about object-oriented programming and its concepts and methods
- Comprehensive knowledge of programming C++
- The ability to apply independently this knowledge when creating smaller Programs C++

Content
- Introduction: History, Differences to the "traditional" programming, applications
- Basics
  - Data encapsulation
  - Abstract data types
  - Motivation object
  - Motivation class
- Object orientation C++
  - Classes and objects
- Constructors and destructors
- Heredity
- Data encapsulation
- Polymorphism and Dynamic Binding
- Peculiarities from C++
  - Input and output (console, file)
  - Overloaded operators
  - Static member and Static Methods
  - Copy constructors

Access or recommended requirements
- Lecture "Introduction to Programming"
- Lecture "Foundations of computer science"
(or or equivalent)

Types of exam
Written exam fro 90 Min.

Methods
Seminars and practical exercises, partly group work

Literature
- Erich Gamma, Richard Helm, Ralph Johnson, John Vlissides: Design Patterns: Elements of Reusable Object Oriented Software. Addison-Wesley, ISBN 0-201-63361-2
Module: Algorithms and Data Structures

Module number  O-07
Module responsible  Prof. Dr. Peter Jüttner
Course specialization

Course number and course name
zero O2104 Algorithms and Data Structures

Semester  2
Length of the Module  1 Semester

Module frequency

Course type  Mandatory
SWS  4.0
ECTS  5.0
Workload  Total: 0.0 hours

Teaching-/Course language  German

Objectives
- Knowledge and understanding of the concept „Algorithms“ and properties of algorithms.
- Knowledge and understanding of the term "recursion".
- Knowledge and understanding of important algorithms for searching and sorting out data.
- Knowledge and understanding of important dynamic data structures.
- The ability to understand these principles and apply them independently on examples.

O2104 Algorithms and Data Structures

Objectives
- Knowledge and understanding of the concept „Algorithms“ and properties of algorithms.
- Knowledge and understanding of the term "recursion".
- Knowledge and understanding of important algorithms for searching and sorting out data.
- Knowledge and understanding of important dynamic data structures.
- The ability to understand these principles and apply them independently on examples.

Contents
Seminars and practical exercises, partly group work

Access or recommended requirements
Lectures:
- Introduction to Programming
- Foundations of computer science
Test type
Written exam, 90 Min.

Literature
- Algorithmen und Datenstrukturen, Skript zur Vorlesung, Dieter Hofbauer und Friedrich Otto, FB Elektrotechnik / Informatik und FB Mathematik / Informatik, Universität Kassel
- Algorithmen und Datenstrukturen, Vorlesungsskript, Gunter Saake, Kai-Uwe Sattler Universität Magdeburg, Juli 2000
- Uwe Schöning: Algorithmik, oder Algorithmen - kurz gefasst, Spektrum, ST 134 S365
- Uwe Schöning: Theoretische Informatik - kurz gefaßt, Spektrum, ST 130 S365
- R. Sedgewick: Algorithmen in Java, Pearson, oder Algorithms in Java, Addison-Wesley, ST 250 J35
- M. Goodrich, R. Tamassia: Data Structures and Algorithms in Java, Wiley, ST 265 G655
- V. Heun, Grundlegende Algorithmen, Vieweg, ST 134 H593
- H. Gumm, M. Sommer: Einführung in die Informatik, Oldenbourg, ST 110 G974
- W. Küchlin, A. Weber: Einführung in die Informatik, Springer-Verlag, ST 110 K95
- J. Kleinberg, E. Tardos: Algorithm Design, Addison-Wesley, ST 134 K64
Module: Soft skills

Module number: O-08
Module responsible: Prof. Peter Schmieder
Course specialization:
Course number and course name:
  zero O2106 Rhetoric & Communication
  O2107 English for engineers
  O2105 Business Administration
Semester: 1, 2
Length of the Module: 2 Semester
Module frequency: Mandatory
Course type: Mandatory
SWS: 8.0
ECTS: 8.0
Workload: Total: 0.0 hours
Teaching-/Course language: German and English

Course Objectives

The students will learn about the basics, purposes and content of Soft Skills. Through this, the students will deepen their knowledge on impairment and benefits for direct professional practices.

The students use presented scientific models or tools directly in order to analyse its practical benefits and reflect their own implementation skills. Here should be recognized the direct links between professional success and the application of the presented skills.

The students will evaluate and examine the analysis of the contents. This way they will generate a deeper implementation and relevant self-understanding about their own behaviour, through self-reflections. Ultimately this course will cover the „employability“, which is also required in the undergraduate level.

Side facts and Concepts (e.g. about Communication, NLP, Presentation and rhetoric) are mainly about process-oriented knowledge (e.g. Briefings, Self presentations and negotiations). Through the analysis of strengths and weaknesses will each personality’s development and social understanding promoted.

It is all about a clear social and emotional horizon expansion, particularly on how to support the future professional success.
O2106 Rhetoric & Communication

objectives

The students will learn about the basics, purposes and content of Soft Skills. Through this, the students will deepen their knowledge on impairment and benefits for direct professional practices.

The students use presented scientific models or tools directly in order to analyse its practical benefits and reflect their own implementation skills. Here should be recognized the direct links between professional success and the application of the presented skills.

The students will evaluate and examine the analysis of the contents. This way they will generate a deeper implementation and relevant self-understanding about their own behaviour, through self reflections. Ultimately this course will cover the „employability“, which is also required in the undergraduate level.

Side facts and Concepts (e.g. about Communication, NLP, Presentation and rhetoric) are mainly about process-oriented knowledge (e.g. Briefings, Self presentations and negotiations). Through the analysis of strengths and weaknesses will each personality’s development and social understanding promoted.

It is all about a clear social and emotional horizon expansion, particularly on how to support the future professional success.

Content

1. What are Soft Skills?
   1.1 History and meaning
   1.2 Definition and Boundaries
   1.2.1 Expertise
   1.2.2 Social skills
   1.2.3 methodological skills
   1.2.4 Personal Competencies
   1.3 Use and applicability

1. Selected key skills
   2.1 Communication
   2.1.1 Watzlawick
   2.1.2 Schulz von Thun
   2.1.3 Gordon
   2.1.4 NLP
   2.1.5 TA
2.1.6 Applications exercises, particularly in negotiations and engineering requirements
2.2 Self-reflection
  2.2.1 Self-confidence
  2.2.2 Self-knowledge
  2.2.3 Possibilities and limitations of personality tests
  2.2.4 Application in interviews and Assessments
  2.2.5 Implications for personal and social behaviour
2.3 Presentation techniques and rhetoric
  2.3.1 Strength and effect of the language
  2.3.2 Rules and boundaries of a good presentation
  2.3.3 Non-verbal communication
  2.3.4 Media Technical Communications
  2.3.5 EXKURS 1: Aristoteles and Hollywood
  2.3.6 EXKURS 2: Modern brain research, constructivism and behaviourisms

1. Concrete application of Soft Skills
3.1 Presentations
3.2 Skill-analysis of media products
3.3 Feedback practices

Access or recommended requirements
none

Types of Test
Written exam, of 90 Min.

Methods
Seminars and lectures with in and outdoor activities, group work, individual projects and evaluated presentations

Literature


O2107 English for Engineers

Content
- Magnetism and electricity
- Batteries
- General technical vocabulary
- Types of energy
- Mathematical operations
- Materials and their properties
- Tools
- Shapes
- Short presentations
- Review of particular grammar topics (e.g. adverbs & adjectives, superlatives & comparatives, passive forms, if-clauses, etc.)

Access or recommended requirements
none

Test Type
Written exam of 90 Min.

Methods
Seminar instruction and practice, independent study

Literature


**O2105 Business Administration**

**Test Type**
Written Exam, 90 Min.
**Module: General Science, mandatory elective**

<table>
<thead>
<tr>
<th><strong>Module number</strong></th>
<th>O-09</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Module responsible</strong></td>
<td>Prof. Dr. Andreas Grzemba</td>
</tr>
<tr>
<td><strong>Course specialization</strong></td>
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<td><strong>Course number and course name</strong></td>
<td></td>
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<tr>
<td></td>
<td>O3101 General Science, mandatory elective 2</td>
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<td>O2108 General Science, mandatory elective 1</td>
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<tr>
<td><strong>Semester</strong></td>
<td>2, 3</td>
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<td><strong>Length of the Module</strong></td>
<td>2 Semester</td>
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<td><strong>Course type</strong></td>
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<td><strong>ECTS</strong></td>
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<tr>
<td><strong>Workload</strong></td>
<td>Total: 0.0 hours</td>
</tr>
</tbody>
</table>

Teaching-/Course language  **German**

Module Objective  
Deepen your knowledge in the field of General Sciences

**O3101 General Sciences, mandatory elective 1**

**Objective**  
Deepen your knowledge in the field of General Sciences

**Content**  
Module description of the selected course

**Type of Test**  
Written Exam of 90 Min.

**O2108 General Sciences, mandatory elective 2**

**Objective**  
Deepen your knowledge in the field of General Sciences

**Content**  
Module description of the chosen course

**Exam Type**  
Written Exam of 90 Min.
Module: Software Engineering

Module number  O-10
Module responsible  Prof. Dr. Peter Jüttner
Course specialization
Course number and course name  O3102 Software Engineering
Semester  3
Length of the Module  1 Semester
Module frequency
Course type  Mandatory
SWS  6.0
ECTS  8.0
Workload  Total: 0.0 Hours
Teaching-/Course language  German

O3102 Software Engineering

Content
- Motivation und Definition
- Elements of Software Engineering
- Methodology
  - Requirements Engineering
  - Software design (general)
  - Software design (object oriented analysis and design)
- Implementation
- Code Metrics
- Software Test
- Software quality assurance

Access or recommended requirements
Classes
- Foundations of computer science
- Introduction to Programming
- Object-oriented Programming

Test Type
Written exam of 90 Minutes

Methods
- Seminars and practical exercises, partly group work
- Internship along the semester in group work

Literature
- H. Balzer, Lehrbuch der Software-Technik, Spektruk Akademischer Verlag
- I. Sommerville, Software Engineering, Addison Wesley Verlag
- B. Kahlbrandt, Software-Engineering mit der UML, Springer Verlag
- C. Rupp et. al. UML 2 - Glasklar, Hanser Verlag
Module: Mandatory elective - Project

Module Number 0-11
Module responsible Prof. Dr. Gerald Kupris

Course Specialization
Course number and course name O4101 Mandatory elective - Project
Semester 4
Length of the Module 1 Semester
Frequency of the Module
Course type Mandatory
SWS 4.0
ECTS 5.0
Workload Total: 0.0 hours
Teaching-/Course language German

Objective
- Be able to perform independently a small development project (SW and/or HW) within the framework of a group.

O4101 Mandatory elective-Project
- Be able to perform independently a small development project (SW and/or HW) within the framework of a group.

Content
- Analysing a task
- Plan a project
- Conduct a project
- Present the project outcomes

Access or recommended requirements
- To have attended the class of the prior semester

Test Types
Written exam, 90 Min

Methods
- Study on your own
- Coaching by the persons handing out the tasks
Module: Database

Module number: O-12
Module responsible: Prof. Dr. Wolfgang Dorner
Course specialization:  
Course number and course name: O4102 Database
Lecturer: Prof. Dr. Wolfgang Dorner
Semester: 4
Length of the Module: 1 Semester
Module frequency: yearly
Course type: Mandatory
Level: Undergraduate
SWS: 4.0
ECTS: 5.0
Workload:  
Attendance: 60.0 hours
Self study: 90.0 hours
Total: 150.0 hours

Teaching-/Course language: German

Objective
The Module has the following objectives:
Be able to describe the developing process for database.
Know about the Elements from an Entity-Relationship-Model
Be able to create an an Entity-Relationship-Model for database
Be able to recognize anomalies and to correct them in a table
Be able to manage databases through database management systems
Be able to implement Database inquiries through SQL
Know about the DBMS function

O4102 Database

Objective
The Module has the following objectives:
Be able to describe the developing process for database.
Know about the Elements from an Entity-Relationship-Model
Be able to create an an Entity-Relationship-Model for database
Be able to recognize anomalies and to correct them in a table
Be able to manage databases through database management systems
Be able to implement Database inquiries through SQL
Know about the DBMS function

Content
1 Initiation
1.1 Introduction
1.2 Why Databases?
Access or recommended requirements
None
Computer science basic courses

Test Type
Presentation that accumulate for the final grade an a written exam of 90 Min.
Methods
Classes with Exercises

Literature
Module: Project Management

<table>
<thead>
<tr>
<th>Module number</th>
<th>O-13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Module responsible</td>
<td>Prof. Dr. Wolfgang Dorner</td>
</tr>
<tr>
<td>Course specialization</td>
<td></td>
</tr>
<tr>
<td>Course number and course name</td>
<td>O4103 Project management</td>
</tr>
<tr>
<td>Semester</td>
<td>4</td>
</tr>
<tr>
<td>Length of the Module</td>
<td>1 Semester</td>
</tr>
<tr>
<td>Module frequency</td>
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<tr>
<td>Course type</td>
<td>Mandatory</td>
</tr>
<tr>
<td>SWS</td>
<td>4.0</td>
</tr>
<tr>
<td>ECTS</td>
<td>5.0</td>
</tr>
<tr>
<td>Workload</td>
<td>Attendance: 60.0 hours</td>
</tr>
<tr>
<td></td>
<td>Self study: 90.0 hours</td>
</tr>
<tr>
<td></td>
<td>Total: 150.0 hours</td>
</tr>
</tbody>
</table>

Teaching-/Course language  German

Objective
The students will learn in the class the most important content of (IT-) Project Management:
- Create a project contract
- Create requirement and functional specifications
- Develop a project plan and calculate expenses for a project
- Employ appropriate software tools for support

O4103 Project management

Objectives
The students will learn in the class the most important content of (IT-) Project Management:
- Create a project contract
- Create requirement and functional specifications
- Develop a project plan and calculate expenses for a project
- Employ appropriate software tools for support

Content
1. The Project Definition
2. Project Phases
   2.1 Project Order
   2.2 Project Planning and Delivery
   2.3 Project controlling
2.4 Project completion and documentation
3. Allocation of projects
3.1 Client and contractor perspective
3.2 Engineering requirements
3.3 Loads and specifications
3.4 Interface to agile methods
4. Tools
4.1 Visio
4.2 MS Project
4.3 MS Team Foundation Server and Interface
4.4 Excel in Project management
5. On-going project work

**Test type**
Written exam, 90 Min

**Methods**
Seminars with on-going exercises

**Literature**
Module: Research Methods

Module number  O-14
Module responsible  Prof. Dr. Wolfgang Dorner
Course specialization
Course number and course name  O7101 Research methods
Semester  7
Length of the Module  1 Semester
Course type  Mandatory
Level  Undergraduate
SWS  4.0
ECTS  5.0
Workload  Attendance: 60.0 hours
Self Study: 50.0 hours
Virtual share: 40.0 hours
Total: 150.0 hours
Teaching-/Course language  German

O7101 Research methods

Objectives
The students should understand how to apply methods and procedures in a scientific context.
After finishing this module:

- The students know the process of a scientific project,
- The students know how to formulate a research question and a hypothesis
- The students know about the most important national databases as well as of literature research methods
- The students know how to formulate a method proposal in order to analyse deeper a scientific problem
- The students know how to create a rudimentary theory paper and a simple literature review

Content
1. Introduction to scientific working
2. Sequence and structure of scientific papers
3. Literature research and literature study
4. Writing scientific papers
   4.1 With Word
   4.2 With LATEX
5. Deep statistic
   5.1 Repetition of Basic knowledge
5.2 Descriptive statistics
5.3 Explorative Statistic
6. Visualization of scientific data

**Test Type**
Accumulative grades of presentations

**Methods**
Classes and Seminars, virtual course

**Literature**
Module: Bachelor thesis and colloquium

Module number  O-15
Module responsible  Prof. Dr. Andreas Grzemba
Course specialization
Course number and course name  
O7103 Bachelor colloquium
O7102 Bachelor thesis
Semester  7
Length of the Module  1 Semester
Module frequency
Course type  Mandatory
SWS  4.0
ECTS  15.0
Workload  Total: 0.0 hours
Teaching-/Course language  German

Objectives
The Bachelor thesis and the project results shall be presented in a final presentation to targeted groups.
The knowledge and abilities obtained through the studies shall be applied in a project in the field of applied computer science methods.
A problem should be structured within a given deadline, processed systematically, using scientific methods, and finally documented in a transparent way.

O7103 Bachelor colloquium
Objectives
The Bachelor thesis and the project results shall be presented in a final presentation to targeted groups.

Access or recommended requirements
Bachelor thesis completed

Test type
Written exam, 90 Min.

O7102 Bachelor thesis
Objectives
The abilities and knowledge learned during the studies shall be applied in a project in the field of applied computer science.
A problem should be structured within a given deadline, processed systematically, using scientific methods, and finally documented in a transparent way.

**Content**
Individual topic

**Access or recommended requirements**
Formal: at least 160 ECTs
Content: Knowledge and Ability to apply the studies content

**Test Type**
Written exam, 90 Minutes
Module: Digital technology

Module number O-30
Module responsible Prof. Dr. Robert Bösnecker
Course specialization embedded Systems
Course number and course name O3111 Digital technology
Semester 3
Length of the Module 1 Semester
Module frequency
Course type Mandatory
Level
SWS 4.0
ECTS 5.0
Workload Total: 0:00 hours
Teaching-/Course language German

Content

Basic concepts of digital technology
Number systems: Denominational number system, BCD-number representation,
Calculate with Dual numbers, Hexadecimal and BCD numbers
Codes: Codes for lengths- and angle measurements, coding
alphanumeric signs, characteristics from Codes
Boolean algebra: basic operations, composite operators
(NAND, NOR, EXOR), calculation rules
Functions: Normal forms, simplification (KV-Diagram,
Quine/McCluskey), NAND- and NOR-Representation
Switching Networks: exemplary treatment of common function modules (Code
converter, multiplexer / demultiplexer,Comparators, arithmetic circuits)

Memory elements:
Basic-Flip-flops, RS-, D- und JK-FFs,
clock control
(Level, slope control),
Master-Slave-Principle
Circuits with Flip-flops:
Counter (asynchronous, synchronous),
Frequency divider,
Parallel-Register,
Shift registers,
Synchronous control works,
Finite state machines
O3111 Digital technology
Specialisation
Embedded Systems

Test Type
Written exam, 90 Min
Module: Deepening in Electro technology

Module number O-31
Module responsible Prof. Dr. Robert Bösnecker
Course specialization Embedded systems
Course number and course name deepening in electro technology
Semester 3
Length of the Module 1 Semester
Module frequency
Course type Mandatory
Level
SWS 4.0
ECTS 5.0
Workload Total: 0.0 hours
Teaching-/Course language German

Content
- Deeper analysis of Transfer Functions
- NY Quist plot, Bode-plots
- dB calculation
- Filter (passive Filter)
Low pass, high pass, band pass, band stop, all pass
Various filter systems
Apply NY Quist plots and Bode plots on filters
Filter design method (Tscheby, Bessel, Butterworth, etc.)
- Fourier Transformation
(continuous waveforms)
- Laplace Transformation

If there is time left:
active filter with OpAmps.

O3112 Deepening in Electro technology

Specialization
Embedded systems

Test type
Written Exam of 90 minutes
Module: Measurement technology

Module number  O-32
Module responsible  Prof. Dr. Martin Jogwich
Course specialization  embedded systems
Course number and course name  O3113 Measurement technology
Semester  3
Length of the Module  1 Semester
Module frequency
Course type  Mandatory
SWS  4.0
ECTS  5.0
Workload  Total: 0.0 hours
Teaching-/Course language  German

Objectives
Acquire knowledge to understand measurements from predefined metrics, knowledge from measurement techniques and structures and their components. Especially amplifier circuits.

O3113 Measurement technology

Specialization
Embedded systems

Objective
Acquire knowledge to understand measurements from predefined metrics, knowledge from measurement techniques and structures and their components. Especially amplifier circuits.

Content
Basics (metrological structures, accuracy criteria, system response)
Measurement of electrical sizes (Current, voltage, power, active and reactive resistors)
Components (Sensors, oscilloscopes, amplifiers)
Measurement from non-electrical sizes (geometric quantities, pressures / forces / torques, temperatures, volume and mass flows)

Access or recommended requirements
Formal: none
Content-wise: If possible have attended the course „Basics of Sensor Systems“ (1. Semester) or a similar course. It is best if a good grade was obtained in the exam.
**Test Type**
Written exam of 90 minutes

**Methods**
Seminars

**Literature**
W.-J. Becker, K. W. Bonfig, K. Höing: Handbuch Elektrische Messtechnik (Hüthig-Verlag)
K. Bergmann: Elektrische Messtechnik (Vieweg+Teubner Verlag)
G. Heyne: Elektronische Messtechnik (Oldenbourg Verlag)
R. Lerch: Elektrische Messtechnik (Springer Verlag)
Th. Mühl: Einführung in die elektrische Messtechnik (Vieweg + Teubner)
J. Niebuhr, G. Lindner: Physikalische Messtechnik mit Sensoren (Oldenbourg Verlag)
R. Parthier: Messtechnik (Vieweg+Teubner Verlag)
W. Pfeiffer: Elektrische Messtechnik (VDE Verlag)
E. Schrüfer: Elektrische Messtechnik (Hanser Verlag)
N. Weichert, M. Wülker: Messtechnik und Messdatenerfassung (Oldenbourg-Verlag)
Module: Microcomputer technology

Module number         O-33
Module responsible    Prof. Dr. Gerald Kupris
Course specialization Embedded systems
Course number and course name O3114 Microcomputer technology
Semester              3
Length of the Module  1 Semester
Module frequency      
Course type           mandatory
SWS                   4.0
ECTS                  5.0
Workload              Total: 0.0 hours
Teaching-/Course language German

Objective
Knowledge about general construction of microcomputers, in particular microcontrollers,
Knowledge of the use of various classes of microcontrollers,
Knowledge of the general structure of programs for microcontrollers,
Development of simple programs for microcontrollers using the example of Cortex,
Interfaces and features of microcontrollers.

O3114 Microcomputer technology
Specialization
Embedded Systems

Objectives
Knowledge about general construction of microcomputers, in particular microcontrollers,
Knowledge of the use of various classes of microcontrollers,
Knowledge of the general structure of programs for microcontrollers,
Development of simple programs for microcontrollers using the example of Cortex, Interfaces and features of microcontrollers.

Content
Construction of microcomputers and microcontrollers
Programming and debugging interfaces
Reading and writing registers
I/O-Pins, Describing and reading single bits
Clock generation, and CPU processing power Interrupts
Memory
Timer and PWM, Watchdog-Timer
A/D-Wandler
Synchronous interfaces: SPI und IIC
Asynchronous interfaces: UART und CAN
Microcontroller in the hardware environment
Power consumption, and low power modes

**Test Type**
Written Exam of 90 minutes

**Methods**
Seminars
Lab Project/internship

**Literature**
Schaaf: Mikrocomputertechnik, 5. Auflage 2010 Hanser Verlag, München,
Beierlein: Taschenbuch Mikroprozessortechnik, 4. Auflage, 2011, Hanser Verlag, München,
Bähring: Mikrorechner-Technik 1&2, Springer-Verlag, 2002
Module: Electronic Components and Circuits

Module number            O-34  
Module responsible       Prof. Dr. Gerald Kupris  
Course specialization    Embedded systems  
Course number and course name  O4111 Electronic Components and Circuits  
Semester                4  
Length of the Module    1 Semester  
Module frequency         
Course type              mandatory  
SWS                     4.0  
ECTS                    5.0  
Workload                Total: 0.0 hours  
Teaching-/Course language German

Objective
Knowledge of the structure and the function of electronic components  
Structure and function of the most important semiconductor devices  
Use of components in electronic circuits  
Basic circuits of electronic  
Reading and understanding schematics  
Design of electronic assemblies

O4111 Electronic Components and Circuits

Specialization
Embedded systems

Objectives
Knowledge of the structure and the function of electronic components  
Structure and function of the most important semiconductor devices  
Use of components in electronic circuits  
Basic circuits of electronic  
Reading and understanding schematics  
Design of electronic assemblies

Content
Passive components  
Fundamentals of Semiconductor Devices  
PN-Transition
Semiconductor diode: Structure, characteristic, operations
Diode circuits, diode types
LEDs and photovoltaic cells, optocouplers
Bipolar Transistors
Basic circuit of the bipolar transistor
Differential amplifier
NE555
MOSFET-Transistors
CMOS-Logic
Thermistors, TRIACs, power components
Voltage Regulators
Design and manufacture of electronic assemblies

**Test Type**
Written exam of 90 minutes

**Methods**
Seminars
lab Project/internship

**Literature**
Tietze / Schenk: Halbleiter-Schaltungstechnik, Springer Verlag, Berlin 2009
Wilfried Plaßmann, Detlef Schulz: Handbuch Elektrotechnik, Grundlagen und Anwendungen für Elektrotechniker
Paul A. Tipler, Gene Mosca: Physik für Wissenschaftler und Ingenieure, Spektrum Akademischer Verlag, August 2009
Module: Computer Networks

Module number: O-35
Module responsible: Prof. Dr. Peter Jüttner
Course specialization: Embedded Systems

Course number and course name: O4112 Computer Networks

Semester: 4
Length of the Module: 1 Semester

Module frequency: mandatory
Course type: mandatory
SWS: 4.0
ECTS: 5.0
Workload: Total: 00:00 hours
Teaching-/Course language: German

Objectives
- Knowledge and understanding of the structure and operation of computer networks
- Ability to apply these skills in the coupling of computers

O4112 Computer Networks

Specialization
Embedded systems

Objectives
- Knowledge and understanding of the structure and operation of computer networks
- Ability to apply these skills in the coupling of computers

Content
- Definition / Motivation from Computer Networks
- History
- Examples
- Communication models
- Classification
- ISO-Layers (Definition and tasks)
  - Physical Layer
  - Data Link Layer
  - Network Layer
  - Transport layer
- Ethernet, TCP / IP

**Access / Needed requirements**

Classes
- Basics of computer science
- E-technological

**Test Type**

Written exam of 90 Minutes

**Methods**

Seminars with practical exercises, partly Group work

**Literature**

- Axel Sikora: Technische Grundlagen der Rechnerkommunikation, Carl Hanser Verlag, ISBN 3-446-22455-6
Module: Real-Time Systems

Module Number: 0-36
Module responsible Prof. Dr. Peter Jüttner
Specialization Embedded Systems
Course number and course name O4113 Real-time Systems
Semester 4
Length of the Module 1 Semester
Frequency of the Module
Course Type Mandatory
SWS 4.0
ECTS 5.0
Workload Total: 0:00 hours
Course Language: German

Objectives
- Knowledge and understanding from the main Definitions and Principles for Programing real-time
- The ability to apply these definitions and principles on examples

O4113 Real-time Systems
Specialization Embedded Systems

Goals
- Knowledge and understanding from the main Definitions and Principles for Programing real-time
- The ability to apply these definitions and principles on examples

Content
- Introduction (History, Definitions, Examples)
- Classification form Real-Time Systems (hard / soft real-time)
- Operating System Concepts
- Architecture
- Scheduling
- Programming
- Safety-Critical Applications
- Real-time algorithms
- Petri nets
- Multiprocessor systems
- Design of operating systems
**Access/ Needed requirements**

Classes:
- Introduction to Programming
- Basics of computer science
- Algorithms and data structure

**Test Type**
Written exam of 90 minutes

**Methods**
Seminars with practical tasks, probably also group works

**Literature**
- Andrew S. Tanenbaum, Moderne Betriebssysteme, Pearson Studium, ISBN: 978-3-8273-7342-7
- Jürgen Quade, Harte und weiche Echtzeitsysteme - (Material zur Vorlesung Echtzeitsysteme - I+II im Studienfach Technische Informatik an der Hochschule Niederrhein), http://w3-o.cs.hm.edu/~mfischer/WS2004_05/ezs_buch.pdf
Module: Internship

Module number: O-37
Module responsible: Prof. Dr. Gerald Kupris
Course specialization: Embedded Systems

Course number and course name
- O5111 Internship ES
- O5113 Internship complements ES
- O5112 practice Seminar ES

Semester: 5
Length of the Module: 1 Semester
Frequency of the Module: PLV, Mandatory

SWS: 4.0
ECTS: 30.0
Workload: Total: 0.0 hours
Course language: German

Objectives
- Expand and deepened on the aspects learned through the practical experience
- Learn about the meaning of group work;
- Present the tasks performed during the internship as well as the results of such tasks.

O5111 Internship ES

Specialization: Embedded Systems

Objectives
- Expand and deepened on the aspects learned through the practical experience
- Learn about the meaning of group work;
- Present the tasks performed during the internship as well as the results of such tasks.

Content
Individual topic choice

Access/ Needed requirements
Formal: At least 70 ECTS;
Content-wise: Knowledge and ability to apply the content of the studies from the Bachelor studies
Completing successfully the Internship seminar is a requirement in order to pass this module and to obtain the necessary credits for the internship.

**Test Type**
Written exam of 90 minutes

**Methods**
Internship

**O5113 Internship complements ES**

**Course Specialization**
Embedded Systems

**Test Type**
Written exam of 90 minutes

**O5112 Practice Seminar ES**

**Course Specialization**
Embedded systems

**Test Type**
Written exam of 90 minutes
Module: Hardware-Modelling
Module number: O-38
Module responsible: Prof. Dr. Robert Bösnecker
Course Specialization: Embedded Systems
Course number and course name: O6111 Hardware-Modelling
Semester: 6
Length of the Module: 1 Semester
Frequency of the Module: Mandatory
Level
SWS: 4.0
ECTS: 5.0
Workload: Total: 0.0 hours
Course language: German

Access/ Needed requirements
Digital technology 1 and 2

Content
- Introduction to hardware architecture
- Modelling of circuits in VHDL
- Basic design of microcontroller systems
- Interfaces and peripheral control
- Applied use of VHDL in a EPLD or FPGA
- Practical application of architectures

O6111 Hardware-Modelling
Course Specialization: Embedded Systems

Test Type
Written exam of 90 minutes
Module: Numerical methods

Module number: O-39
Module responsible: Prof. Dr. Peter Jüttner
Course specialization: Embedded Systems
Course number and course name: 06112 Numerical Methods
Semester: 6
Length of the Module: 1 Semester
Frequency of the Module: Mandatory
Course type: Mandatory
SWS: 4.0
ECTS: 5.0
Workload: Total: 0.0 hours
Course language: German

Objectives
- Knowledge and understanding from the representation and processing of floating point numbers in computers and the resulting problems
- Knowledge and understanding of some fundamental methods of numerical analysis to solve mathematical problems
- The ability to apply this knowledge when programming and analysing floating-point calculations in the C programming

Content
- Definition
- Error types on calculations with floating point numbers (through examples)
- Error analysis based on the representation of floating-point numbers as machine numbers
- Basic arithmetic
- Conditioning and numerical stability
- Error propagation
- Examples of numerical algorithms
- Gauss Algorithms (including Matrix- und vectors)
- Differential Equations
- Obtaining roots

**Access/ Needed requirements**

Class:
- Math I/II
- Basics of computer science
- Introduction to Programing

**Test Types**

Written exam of 90 minutes

**Methods**

Seminars with practical exercises, partly group work

**Literature**

- Hermann Schichl: Numerik 1, Skriptum zur Vorlesung WS 2000/01, Universität Wien, [http://www.mat.univie.ac.at/~herman/skripten](http://www.mat.univie.ac.at/~herman/skripten)
- Serge Kräutle: Numerische Mathematik I, Wintersemester 2007/08, Universität Erlangen, [http://www1.am.uni-erlangen.de/~kraeutle/skripte.html](http://www1.am.uni-erlangen.de/~kraeutle/skripte.html)
Module: System Programming

Module number: 0-40
Module responsible: Prof. Dr. Andreas Grzemba
Course specialization: Embedded systems
Course number and course name: 06113 System programming
Semester: 6
Length of the Module: 1 Semester
Frequency of the module: yearly
Course type: Mandatory
Level: Bachelor
SWS: 4.0
ECTS: 5.0
Workload: Total: 0.0 hours
Course language: German

Objective

The students will learn concrete approaches for the design and implementation of modular operating systems. They will acquire detailed knowledge about the structure of individual Operating system components and the impact of increased modularity of the operating system.

For this the students should know the advantages (greater protection, increased stability, improved adaptability, etc.) and also the problems of modularization (increased communication overhead, less flexible interfaces, poor performance, etc.)

The students will know the current technical state of modular operating systems and will gain insight on how their solutions can be implemented in practical systems.

During an internship, the student shall be able to work and implement a Design of the most important sub-components of an operating system, according to the common principles

Access/Needed requirements
Successfully completed the course real-time systems

Content
Core interfaces
File Systems
Tasks/Scheduling
Driving devices
Internship in an embedded operating system
Teaching methods
Seminars/ Internship

Literature


O6113 System Programming
Course Specialization
Embedded Systems
Test Type
Written exam of 90 minutes
Module: Digital Signal Processing

Module number: O-41
Module responsible: Prof. Dr. Nikolaus Müller
Course specialization: Embedded Systems
Course number and course name: O6114 Digital signal processing

Semester: 6
Length of the module: 1 Semester
Frequency of the module: 
Course type: Mandatory
SWS: 4.0
ECTS: 5.0
Workload: Total: 0.0 hours
Teaching language: German

Objectives
The ability to solve tasks from signal processing with the help of digital systems.
The ability to apply this knowledge on PC- Simulations and on systems with embedded digital signal processing.

O6114 Digital Signal processing

Course Specialization
Embedded Systems

Objectives
The ability to solve tasks from signal processing with the help of digital systems.
The ability to apply this knowledge on PC- Simulations and on systems with embedded digital signal processing.

Content
1. Description form analogy signals in the time and frequency domain
2. Description of time-discrete signals with the aid of the $z$-transform
3. Application environments Matlab and DSP
4. The discrete Fourier transformation (DFT)
5. Functions generator
6. Digital filter (FIR, IIR)

Test Type
Written exam of 90 minutes

Methods
Seminars, Class notes, PC-Simulations
Literature
A. Braun: Grundlagen der Regelungstechnik. Fachbuchverlag Leipzig, 2005;
O. Föllinger: Regelungstechnik. 10. Auflage, Hüthig Verlag, 2008;
M. Horn, N. Dourdoumas: Regelungstechnik. Pearson, 2004;
H. Unbehauen: Regelungstechnik I. Verlag Vieweg, 15. Aufl., 2008
Module: Controlling technology
Module number  O-42
Module responsible  Prof. Dr. Nikolaus Müller
Course specialization  Embedded Systems
Course number and course name  O6115 controlling technology
Semester  6
Length of the Module  1 Semester
Frequency of the module
Course type  Mandatory
SWS  4.0
ECTS  5.0
Workload  Total: 0.0 hours
Course language  German

Objective
Basic understanding of the system dynamics;
Solve simple tasks from Control technology

O6115 Controlling technology

Course Specialization
Embedded System

Objectives
Basic understanding of the system dynamics;
Solve simple tasks from Control technology

Content
· Introduction
· Description of dynamic systems in the block diagram
· Characteristics from Controlling (Analysis)
· Control Design (synthesis)
· Structural (cascade control a.m.)

Access/ Needed requirements
Formal: none;
Content-wise: Mathematics: Complex Numbers, Laplace transformation, Physics

Test Type
Written exam of 90 minutes

Methods
Seminars, Class notes, PC-Simulation

Literature
A. Braun: Grundlagen der Regelungstechnik. Fachbuchverlag Leipzig, 2005,
O. Föllinger: Regelungstechnik. 10.Auflage, Hüthig Verlag, 2008;
M. Horn, N. Dourdoumas: Regelungstechnik. Pearson, 2004;
H. Lutz / W. Wendt: Taschenbuch der Regelungstechnik. Verlag Harri Deutsch,
7. Aufl., 2007;
H. Mann, H. Schiffelgen, R. Froriep: Einführung in die Regelungstechnik. Hanser
Verlag, 11. Aufl., 2009;
2008;
H. Unbehauen: Regelungstechnik I. Verlag Vieweg, 15. Aufl., 2008
Module: Mandatory elective 1

Module number: O-43
Module responsible: Prof. Dr. Gerald Kupris
Course Specialization: Embedded Systems
Course number and course name: O6116 Mandatory elective 1 ES
Semester: 6
Length of the Module: 1 Semester
Frequency of the Module: 
Course Type: Mandatory elective
SWS: 4.0
ECTS: 5.0
Workload: Total: 0.0 hours
Teaching language: German

Objective
View more detailed the studies content in the field of the elective chosen

O6116 Mandatory elective 1 ES

Course Specialization
Embedded Systems

Objectives
View more detailed the studies content in the field of the elective chosen

Content
The course description of the elective chosen

Test Type
Written exam of 90 minutes
Module: Modelling & simulation
Module number  O-44
Module responsible  Prof. Dr. Peter Jüttner
Course specialization  Embedded Systems
Course number and course name  
null  O7111 Modelling and simulation
Semester  7
Length of the module  1 Semester
Frequency of the module
Course type  Mandatory
SWS  4.0
ECTS  5.0
Workload  Total: 0.0 hours
Teaching language  German

Objectives
- Knowledge and understanding from different methods from modelling and simulation from SW-Systems, components and algorithms
- The ability to apply this knowledge on examples

O7111 Modelling and Simulation
Course Specialization
Embedded systems

Objectives
- Knowledge and understanding from different methods from modelling and simulation from SW-Systems, components and algorithms
- The ability to apply this knowledge on examples

Content
- Pattern
  - Definition
  - Pattern in computer science
  - Pattern for SW-architecture
  - Patter for SW-Design
  - Pattern for SW-Coding (Idiom)
  - Anti-pattern
- Modelling and simulation from System components and algorithms within MATLAB
  - MATLAB Overview
  - MATLAB Programming
  - MATLAB Simulink
  - MATALB State flow
Access/ Needed entry requirements

Classes:
- Basics of computer science
- Introduction to computer science
- Goal oriented programming
- Algorithms and data structure
- Numerical methods

Test Type
Written exam, 90 minutes

Methods
Seminars with practical aspects, partly group work

Literature
- A. Angermann et al., MATLAB-Simulink-Stateflow, Gruindlagen, Toolboxen, Beispiele, Oldenbourg-Verlag, ISBN 978-3-486-58985-6
- E. Gamma, R. Helm, R. Johnson, J. Vlissides, Entwurfsmuster, Addison Wesley, 2001
- William J. Brown, Raphael C. Malveau, Hays McCormick, Anti Patterns, MITP-Verlag, 2004
Module: Mandatory Elective 2

Module number: Prof. Dr. Gerald Kupris
Course Specialization: Embedded Systems
Course number and course name: O7112 Mandatory elective 2 ES
Semester: 7
Length of the Module: 1 Semester
Course type: Mandatory elective

SWS: 4.0
ECTS: 5.0
Workload: Total: 0.0 hours
Teaching language: German

Objective
View in more detail the studies content in the field of the chosen elective

O7112 Mandatory elective 2 ES

Course specialization
Embedded Systems

Objectives
View in more detail the studies content in the field of the chosen elective

Content
Course description of the subject chosen as elective

Test Type
Written exam of 90 minutes
Module: Spatial reference systems and positioning

Module number O-60
Module responsible Prof. Dr. Wolfgang Dorner
Course Specialization Mobile und spatial system
Course number and course name O3121 Spatial reference systems and positioning
Lecturer Patrick Reidelstürz
Semester 3
Length of the Module 1 Semester
Frequency of the Module annually
Course type Mandatory
SWS 4.0
ECTS 5.0
Workload Attendance: 60.0 hours
Independent study: 30.0 hours
Total: 90.0 hours
Teaching language German

Objectives
The students will learn about different spatial reference systems and will be able to differentiate among them.
The students will learn about the functioning of global positioning, especially about GPS.
At the end of the course the student will be able to apply the learned spatial systems as well as the positioning options according appropriate to a certain context.

O3121 Spatial reference systems and positioning

Course Specialization
Mobile und spatial systems

Objectives
The students will learn about different spatial reference systems and will be able to differentiate among them.
The students will learn about the functioning of global positioning, especially about GPS.
At the end of the course the student will be able to apply the learned spatial systems as well as the positioning options according appropriate to a certain context.

Content
(A)Spatial reference systems
1. The basics of spatial reference systems
   1.1 Introduction to spatial reference systems
   1.2 Geoid
   1.3 Distance and height

2. Projections
3. Coordinate Systems
4. Visualization

(B) Positioning
1. Introduction and History of positioning systems
2. Positioning systems
3. Error influences of positioning
4. Current formats and data storage of positioning data
5. Application examples

**Test Type**
Written exam of 90 minutes

**Methods**
Seminars and class practices
Module: Introduction of GIS

O-60
Prof. Dr. Wolfgang Dorner
Mobile und spatial system
O3121 Spatial reference systems and positioning

Lecturer
Patrick Reidelstürz

Semester
3
1 Semester

Frequency of the Module
annually

Course type
Mandatory

SWS
4.0

ECTS
5.0

Workload
Attendance: 60.0 hours
Independent study: 30.0 hours
Total: 90.0 hours

Module number
O-61

Module responsible
Prof. Dr. Wolfgang Dorner

Course Specialization
Mobile und spatial Systems

Course number and course name
O3122 Introducion to Geo information systems (GIS) in Geographic Information Systems (GIS)

Lecturer
Roland Zink

Semester
3

Length of the Module
1 Semester

Frequency of the Module des Moduls

Course type
mandatory

SWS
4.0

ECTS
5.0

Workload
Attendance: 30.0 hours
Independent study: 90.0 hours
Virtual share: 30.0 hours
Total: 150.0 hours

Teaching language
German

Objectives
The students will be able to define Geographical information at the end of the course. Furthermore thy will understand its function and will manage to work on basic spatial issues through ArcGIS, gvSIG and QuantumGIS. The students can capture Geographical data on their own in order to collect it, store it, edit it, analyze it and presen it.
O3122 Introduction to Geographical information systems (GIS)

Objectives
The students will be able to define Geographical information at the end of the course. Furthermore they will understand its function and will manage to work on basic spatial issues through ArcGIS, gvSIG and QuantumGIS.

The students will learn different Geographical formats and can apply them accordingly.

The students can capture Geographical data on their own in order to collect it, store it, edit it, analyse it and present it.

Content
1 Introduction of GIS
  1.1 Definition of GIS
  1.2 Current Applications
2 Operation of GIS
  2.1 Illustration of the real world
  2.2 Georeferencing
  2.3 Layer principle
  2.4 Geoobjects
3 Geodata formats
  3.1 Geometry and topology data
  3.2 Vectors
  3.3 Grids
  3.4 Graphic data
  3.5 factual data
4 Working with Spatial Data
  4.1 Electronic capture of spatial data
  4.2 Quality of spatial data
  4.3 Standardization of spatial data and OGC
  4.4 ATKIS and ALKIS
  4.5 INSPIRE
5 Database systems and data management
  5.1 Data management in GIS
  5.2 Database and database systems
  5.3 Spatial database systems
  5.4 SQL
6 GIS-Software
  6.1 Status and development of software
  6.2 Autodesk Map 3D and Civil 3D
  6.2 ESRI ArcGIS
  6.3 Open Source-Products
6.4 Web-GIS
7. Space acquisition and mapping in GIS
    7.1 Spatial relationships
    7.2 Coordinates
    7.3 Reference Systems
    7.4 Grid designs
    7.5 Coordinate transformations
    7.5 Primary detection methods
    7.6 Secondary detection methods
8. Spatial queries
    8.1 Topological queries
    8.2 Attribute-based queries
    8.3 Geometric analysis
9. Conversions
    9.1 Transformation of coordinate systems
    9.2 Vector to grid
    9.3 Table to grid
7.4 Grid to vector
10. Presentation
    10.1 Graphical representation forms
    10.2 Interactive forms of presentation
    10.3 Web presentations
    10.4 Data Exchange
11. Development of GI systems
12. Outlook, connector and repetition

**Test Type**
Written exam of 90 minutes

**Literature**
Module: Fundamentals of Spatial Sciences

Module number: O-62
Module responsible: Prof. Dr. Wolfgang Dorner
Course specialization: Mobile und spatial systems
Course number and course name: 03123 Fundamentals of space sciences
Lecturer: Roland Zink
Semester: 3
Length of the Module: 1 Semester
Module frequency: Course type: Mandatory
SWS: 4.0
ECTS: 5.0
Workload: Attendance: 60.0 hours
Independent study: 90.0 hours
Total: 150.0 hours
Teaching-/Course language: German

Objectives
The students will be able to define terms of spatial science.
The students know the interfaces between computer science and spatial science.
The students will be able to employ various qualitative and quantitative methods of spatial science, thus being able to detect further areas to explore.
The students can illustrate and classify spatial phenomena mathematically and cartographically in order to apply them in spatial planning.
The student will have at the end of the courses a sound knowledge about spaces and should be able to analyze, question and process complex spatial and interdisciplinary issues.
The students will know the basics of design, modeling and perception of spaces and have knowledge of spatial planning.

03123 Fundamentals of Spatial Sciences

Objectives
The students will be able to define terms of spatial science.
The students know the interfaces between computer science and spatial science.
The students will be able to employ various qualitative and quantitative methods of spatial science, thus being able to detect further areas to explore.
The students can illustrate and classify spatial phenomena mathematically and cartographically in order to apply them in spatial planning.
The student will have at the end of the courses a sound knowledge about spaces and should be able to analyze, question and process complex spatial and interdisciplinary issues.

The students will know the basics of design, modeling and perception of spaces and have knowledge of spatial planning.

**Content**

**I Introduction to the fundamentals of spatial sciences**

1. Importance of place and space and their respective introduction
   1.1 Geographical approaches
   1.2 Computer science approaches
   1.3 Regionalization, globalization and cyberspace

2. Interpretation of place and space
   2.1 Mathematical, physical and Euclidean space
   2.2 Geographical, social and architectural space
   2.3 Further spaces

3. Detection and mapping of areas
   3.1 Cartesian systems
   3.2 Coordinates, position and location
   3.3 Geographic coordinate systems
   3.4 Vectors and grids

4. Capturing geographical spaces
   4.1 Measurement methods: Distance, area, and angle measurement
   4.2 Measurement accuracy
   4.3 Georeferences and referencing methods

5. Practice: Recognition from Geo-spacing and creation of maps

6. Cartographic illustrations geographical spaces
   6.1 Types of cards
   6.2 Cards layout: Colors, symbols and topology
   6.3 3D-Presentations

7. Practice: Cards interpretation

8. Space analysis
   8.1 Spatial descriptions
   8.2 Absolute and relative positions
   8.3 Interaction and diffusion
   8.4 Availability

**II Designing spaces**

1. Spatial planning
   1.1 Spatial structures
   1.2 The sense behind a sustainable space planning
   1.3 Principles of spatial planning

2. Methods of spatial planning
   2.1 Situations analysis
2.2 Potential analysis
2.3 Risk analysis
3. Practices: Spatial planning in examples of the HUD

**III Space modeling**
1. Environmental modeling
   1.1 Geodata: Format, context and use
   1.2 Modeling geodata
   1.3 Computer-supported simulation of environmental processes
2. CAD in the spatial planning
   2.1 Constructions and drawing work
   2.2 Objects and space
   2.3 Software solutions
3. Visualization in 2D and 3D
   3.2 2D-Plans
   3.3 Nuts from 3D-visualization
   3.4 Dynamic 3D- Landscape modeling
4. Geoinformation and Geoinformatics
   4.1 Incorporation of space and information
   4.2 Layer principles
   4.3 Software solutions
5. Spatial systems on the Web
   5.1 Web maps
   5.2 Virtual Globes
   5.3 Router planned
   5.4 Geodata-Services
6. Practice: Environmental Modeling and Simulation Environment

**IV Perception of space**
1. Evaluation of spatial perception
   1.1 Factors influencing the perception of space
   1.2 Cognitive maps and mental maps
2. Empirical Social Research: Quantitative vs. qualitative methods

**V Computer Science and space**
1. Geoinformation and Geoinformatics
   1.1 What is Geoinformation – an introduction
   1.2 Development of the geoinformatics
2. Future areas of Geoinformatics
   2.1 Career options
   2.2 Applications

**VI Outlook, connector and repetition**

**Test Type**
Written exam of 90 minutes

**Methods**
Seminars and exercises
In the exercises: individual-, partner- and group work
Practical teaching sessions on measurement procedures
Computer assisted instruction sequences in the exercises

**Literature**
Module: Mobile Operating Systems

Module number: O-63
Module responsible: Prof. Dr. Wolfgang Dorner
Course specialization: Mobile und spatial systems
Course number and course name: O3124 Mobile Operating Systems
Lecturer: Prof. Dr. Wolfgang Dorner
Semester: 3
Length of the Module: 1 Semester
Module frequency: yearly
Course type: Mandatory
Level: Undergraduate
SWS: 4.0
ECTS: 5.0
Workload:
- Attendance: 60.0 hours
- Independent study: 90.0 hours
- Virtual share: 150.0 hours
Total: 300.0 hours

Teaching-/Course language: German

O3124 Mobile Operating systems

Objectives

The students will learn how to deal with programming based mobile operating systems such as Androids or Windows Phones. After finishing they will dominate the basics from other relevant Program languages (specially C# or Java), will know the basics for construction of an operating system in general, and a mobile operating system and related hardware basics. They will be able to develop independently, smaller application and access on hardware's.

Content
1. Basic Operating Systems
   1.1 Development of operating systems
   1.2 Tasks of an OS
   1.3 Applications and Types
   1.4 Structure
2. Introduction to mobile and embedded operating systems
   2.1 Types and Applications
   2.2 Current/ up-to-date examples
   2.3 Introduction to Androids
Access or recommended requirements
- Basic knowledge about programming and goal oriented programming

Test Types
Written exam of 90 minutes

Methods
Seminars and programming exercises in the computer lab.

As part of the seminar-classes, essential theoretical knowledge will be taught, such as operating systems, hardware architectures and basic elements of the language. Using concrete examples, the students will be introduced to programming exercises in the practical application of the knowledge acquired. Here, the method of problem-based learning is in the foreground and is meant to promote among students the ability for independent acquisition of knowledge and problem-solving skills.
Module: Geoinformation – Application and use

Module number: O-64
Module responsible: Prof. Dr. Wolfgang Dorner
Course specialization: Mobile und spatial systems
Course number and course name: O4121 Geoinformation – Application and use
Semester: 4
Length of the Module: 1 Semester
Module frequency: Mandatory
Course type: Mandatory
SWS: 6.0
ECTS: 5.0
Workload:
- Attendance: 90.0 hours
- Independent study: 60.0 hours
- Total: 150.0 hours

Teaching-/Course language: German

Course Objectives
The course is built on previous knowledge of the "Introduction GIS" and is accompanied by an extensive practical training in integrated geographic information systems.

During the practices the learned outcomes of application-oriented content will be tested/proven from examples.
The student will have an extensive knowledge of the application and use of GIS.
The students will be able to create spatial, statistical and mathematical models for specific tasks and purposefully apply them.
The student is able to transfer the content learned about modelling spatial structures on new issues and adjust it accordingly.
The student has a basic knowledge of VBA programming.

O4121 Geoinformation – Application and use
Objectives
The course is built on previous knowledge of the "Introduction GIS" and is accompanied by an extensive practical training in integrated geographic information systems.

During the practices the learned outcomes of application-oriented content will be tested/proven from examples.
The student will have an extensive knowledge of the application and use of GIS.
The students will be able to create spatial, statistical and mathematical models for specific tasks and purposefully apply them.
The student is able to transfer the content learned about modelling spatial structures on new issues and adjust it accordingly.
The student has a basic knowledge of VBA programming.

**Content**

1. Spatial modelling and simulation - an introduction
2. Introduction to the use of software
3. Data models
   2.1 Hierarchical Data Models
   2.2 Relational/Comparative Data Model
   2.3 Object-Oriented Data Model
4. geometric analysis
   3.1 Geometric Fundamentals
   3.2 Clipping
   3.3 Buffering
   3.4 Surface intersections
   3.5 Point-in-polygon test
   3.6 Adjacency Graph
4. Topological analysis methods
   4.1 Graph Theoretical Foundations
   4.2 Networks analysis
5. Statistical analysis methods
   5.1 Introduction to Statistic
   5.2 Univariate procedure
   5.3 Bivariate method
   5.4 Multivariate methods
   5.5 interpolation methods
   5.6 Cluster Analysis
   5.7 Geostatistics
6. Volume methods
   6.1 Boolean Algebra
   6.2 Fuzzy-Mathematics
   6.3 Relational/Comparative Operators
   6.4 Research method
   6.5 Reclassification
   6.6 Aggregation
7. Simulations
8. Special algorithms
9. VBA Programming in GIS
   9.1 Customizing user Interfaces
   9.2 Creating Controls
   9.3 language syntax and controlling alternatives
9.4 Visual Basic Editor in ArcGIS
9.5 Object-oriented programming and introduction Arc Objects
10. Summary and Outlook

**Access and/or recommended requirements**
The course is built or prior knowledge of “Introduction to GIS” and will be accompanied with a practical training in common GIS systems. The learning outcomes will be tested on adequate examples.

**Test Type**
Written exam of 90 minutes

**Methods**
Seminars and Practices
Individual-, Partner- and Teamwork
Workshops in GIS-lab.

**Literature**
Module: Storage and processing of spatial data

Module number O-65
Module responsible Prof. Dr. Wolfgang Dorner
Course specialization Mobile und spatial systems
Course number and course name O4122 Storage and processing of spatial data
Semester 4
Length of the Module 1 Semester
Module frequency yearly
Course type Mandatory
Level Undergraduate
SWS 4.0
ECTS 5.0
Workload Attendance: 60.0 hours
Independent study: 90.0 hours
Virtual share: 150.0 hours
Total: 300.0 hours

Teaching-/Course language German

O4122 Storage and processing of spatial data

Course Specialization
Mobile and spatial systems

Course Objectives

Students learn relevant data structures, basic algorithms and analytical methods to store spatial data and process it. These should relate specifically to vector and raster data structures. After completing this module, the students will be able to choose different applications data structures, algorithms and fundamental analysis and to implement it in a target language.

They will also understand the possibilities of storing and processing data in the DBMS and will be able to formulate corresponding insertion and query operations for (object-relational) DBMS.

Content
1. Discrete versus continuous phenomena
   1.1 Choosing data structures
   1.2 Fields
   1.3 Data and file formats
2. Vector data
2.1 Construction of vector data
2.2 Mathematical models for the description
2.3 Data structures
3. Graph Theory
3.1 Structure of graphs
3.2 Mathematical Foundations
3.3 Storing and processing of graphics
4. Grid data
4.1 Structure of grid formats
4.2 Mathematical Foundations
4.3 Data structures
4.4 Data and File Formats
5. Special data formats
5.1 TIN
5.2 Voxel
6. Basic algorithms for vector data
7. Basic algorithms for grid data
8. Geodatabases
8.1 Object-Oriented Databases
8.2 Simple features concept
8.3 Geoobjects
8.4 Definition of access on objects in SQL

**Types of Test**
Written exam, 90 minutes

**Methods**
Seminars and programming exercises in the computer lab.
As part of the seminar-classes, essential theoretical knowledge will be taught. Using concrete examples, the students will be introduced to programming exercises in the practical application of the knowledge acquired. Here, the method of problem-based learning is in the foreground and is meant to promote among students the ability for independent acquisition of knowledge and problem-solving skills.
Module: Internship

Module number  O-66
Module responsible  Prof. Dr. Wolfgang Dorner
Course specialization  Mobile and spatial systems
  O5123 Additional, reinforcement practice MRS
  O5122 Practical seminars MRS
  O5121 Internships MRS

Semester  5
Length of the Module  1 Semester
Module frequency
Course type  PLV, Mandatory
Level  Undergraduate
SWS  4.0
ECTS  30.0
Workload
  Attendance: 420.0 hours
  Independent study: 30.0 hours
  Total: 450.0 hours

Course number and course name  German

O5123 Additional, reinforcement practice MRS

Main focus  Mobile and spatial systems

Objectives  Learning content directly related to the practical activity

Content  diverse

Types of test  none

Methods  Seminars, Practices, excursion

O5122 Practical seminar MRS

Focus  Mobile and spatial systems

Objectives  Preparation for the internship

Content  diverse
**Test Type**
LN written

**Methods**
Seminars, Exercises, excursion

**O5121 Internship MRS**

**Focus**
Mobile and spatial systems

**Objectives**
Anchoring and expanding what has already been learned from the experience.
Understand the importance of teamwork.
Presentations about the tasks performed during the internship and the results obtained at work.

**Content**
Individual and studies related topics

**Access or recommended requirements**
Formal: at least 70 ECTs (credits)
Content: Knowledge and application of the topics and content of the Bachelor program;
The successful completion of the internship is a requirement for passing this module and thus for the recognition of ECTS points.

**Test type**
No exam

**Methods**
internship
Module: Special algorithms

Module number O-67
Module responsible Prof. Dr. Wolfgang Dorner
Course specialization Mobile and spatial systems
Course number and course name O6121 Special algorithms
Semester 6
Length of the Module 1 Semester
Module frequency
Course type Mandatory
Level Undergraduate
SWS 4.0
ECTS 5.0
Workload Attendance: 60.0 hours
Independent study: 90.0 hours
Virtual share: 150.0 hours
total: 300.0 hours

Teaching-/Course language German

O6121 Special algorithms

Course Focus
Mobile and spatial systems

Objectives
The students will learn algorithms that are essential for working on spatial data. After finishing the course the students will be able to implement diverse algorithms for the remote sensing, photogrammetry, routing and spatial analysis.

Content
1. Routing and operations in graphs
2. Remote Sensing and index method
3. Photogrammetric processing
4. Analysis algorithms for vector data
5. Grid analysis

Test types
Written exam of 90 minutes

Methods
Seminars and exercises in the computer

Literature
Module: Programming mobile systems

Module number: O-68
Module responsible: Prof. Dr. Wolfgang Dorner
Course specialization: Mobile and spatial systems
Course number and course name: O6122 programming mobile systems
Semester: 6
Length of the Module: 1 Semester
Module frequency: yearly
Course type: mandatory
Level: Undergraduate
SWS: 4.0
ECTS: 5.0
Workload:
- Attendance: 60.0 hours
- Independent study: 90.0 hours
- Virtual share: 150.0 hours
- Total: 300.0 hours

Teaching-/Course language: German

O6122 Programming mobile systems

Course Focus
Mobile and spatial systems

Objectives
The students will develop the ability and knowledge for further implementation in mobile devices. After finishing the course the students will be able to develop comprehensive applications for a specified platform and to apply different techniques (web based applications, native applications and hybrid applications). They can access it on (selected) hardware interfaces and develop context-based applications.

Content
1. Software concepts
   1.1 Native applications
   1.2 Web based applications
   1.3 Hybrid approaches
2. Basic structures of larger applications
3. Web technologies
   3.1 HTML 5
   3.2 XML
   3.3 JavaScript
3.4 JSON
4. Structure and concepts design
5. Deeper view of Java
6. Access to hardware interfaces
7. Libraries and frameworks
8. Usability
9. Context based applications

Access/recommended requirements
- Fundamentals of mobile and embedded operating systems
- Storage and processing of spatial data

Spatial reference systems and positioning

Test type
Written exam of 90 minutes

Methods
Seminars and programming exercises in the computer lab.
During the lectures relevant theoretical basic-knowledge will be taught. Through specific examples the students will be able to apply this knowledge on programming exercises. Here, the method of problem-based learning is in the foreground and is meant to promote among students the ability for independent acquisition of knowledge and problem-solving skills.

Literature
Module: Sensors and hardware-specific programming

Module number  O-69
Module responsible  Prof. Dr. Wolfgang Dorner
Course specialization  Mobile and spatial systems
Course number and course name  O6123 Sensors and hardware-specific programming
Semester  6
Length of the Module  1 Semester
Module frequency
Course type  mandatory
Level  Undergraduate
SWS  4.0
ECTS  5.0
Workload
  Attendance: 60.0 hours
  Independent study: 90.0 hours
  Virtual share: 150.0 hours
  Total: 300.0 hours
Teaching-/Course language  German

O6123 Sensors and hardware-specific programming

Course Focus
Mobile and spatial systems

Objectives
The students will learn about different sensor types in the fields of Remote sensing, positioning and traditional mobile devices. Upon completion of the subject, students may work on selected sensors and sensor data processing.

Content
1. Repetitions of the basics of sensors
2. Sensors Remote Sensing
3. Sensors of spatial measurement techniques
4. Integrated sensors mobile devices
5. Access to hardware interfaces
6. Hardware dependent programming
7. Processing of sensor data

Types of Test
Written exam of 90 minutes
**Module: Architectures for Networked Software Systems**

**Module number** 0-70  
**Module responsible** Prof. Dr. Wolfgang Dorner  
**Course specialization** Mobile and spatial systems  
**Course number and course name** O6124 Architectures for Networked Software Systems  
**Semester** 6  
**Length of the Module** 1 Semester  
**Module frequency** 
**Course type** Mandatory  
**SWS** 4.0  
**ECTS** 5.0  
**Workload**  
Attendance: 60.0 hours  
Independent study: 90.0 hours  
Virtual share: 150.0 hours  
Total: 300.0 hours  
**Teaching-/Course language** German

### Course Focus

During the lectures the students will learn about the most relevant (particularly the internet based-) technologies and standards in order to be able to build OGC solutions for Geodata infrastructure. After this course, the students know the main OGC standards (Simple Feature, WFS, WMS) and systems and technologies that are based on this. They will be able to program interfaces and to access to interfaces of programming. Parallel to this, the students will learn about the proprietary standards and how to integrate it into their own systems.

### O6124 Architectures for Networked Software Systems

**Course focus**  
Mobile and spatial systems  

**Objectives**  
During the lectures the students will learn about the most relevant (particularly the internet based-) technologies and standards in order to be able to build OGC solutions for Geodata infrastructure. After this course, the students know the main OGC standards (Simple Feature, WFS, WMS) and systems and technologies that are based on this. They will be able to program interfaces and to access to interfaces of programming. Parallel to this, the students will learn about the proprietary standards and how to integrate it into their own systems.

**Content**  
1. Internet technologies  
2. Web services
3. Geodata infrastructure
4. OGC Standards
  4.1 Simple Features
  4.2 WFS
  4.3 WMS
5. Proprietary Standards
  5.1 Google Maps API
  5.2 Bing API
6. Access to Web services
7. Develop their own applications using interfaces

Test type
Written exam of 90 minutes

Methods
Seminars accompanied by exercises

Literature
Module: Digital Imaging and Augmented Reality

Module number 0-71
Module responsible Prof. Dr. Wolfgang Dorner
Course specialization Mobile and spatial systems
Course number and course name O6125 Digital Imaging and Augmented Reality
Lecturer Patrick Reidelstürz
Roland Zink
Semester 6
Length of the Module 1 Semester
Module frequency
Course type Mandatory
SWS 4.0
ECTS 5.0
Workload Attendance: 60.0 hours
Independent Study: 90.0 hours
Virtual share: 150.0 hours
Total: 300.0 hours
Teaching-/Course language German

Objectives
The students will learn about processes and options for digital image processing, especially in context with civilian remote sensing.
Remote sensing applications are geared with the voluntary elective "Civilian use of drones and remote sensing."
The students understand the content and meaning of derived remote sensing information and are able to apply and analyse it.
They can interpret continuous process pictorial information and remote sensing.
The student knows the possibilities, the value but also the limitations of augmented reality.
The student knows the function of augmented reality and knows the necessary hardware and software components.
The student will be able to create independently small augmented reality applications.

O6125 Digital Imaging and Augmented Reality
Main Focus
Mobile and spatial systems
Objectives
The students will learn about processes and options for digital image processing, specially in context with civilian remote sensing.
Remote sensing applications are geared with the voluntary elective "Civilian use of drones and remote sensing."

The students understand the content and meaning of derived remote sensing information and are able to apply and analyse it.

They can interpret continuous process pictorial information and remote sensing.

The student knows the possibilities, the value but also the limitations of augmented reality.

The student knows the function of augmented reality and knows the necessary hardware and software components.

The student will be able to create independently small augmented reality applications.

**Content**

1. Introduction of Digital Image Processing in Remote Sensing
2. Sensor support and sensors in remote sensing
   2.1 Satellite Remote Sensing and Sensors
   2.2 Aircraft and UAV-based remote sensing and sensors
3. Post-processing and analysis of remote sensing data
   3.1 Basics of image processing
   3.2 Multispectral analysis, vegetation indices and classification methods
   3.3 Decision tree classification
   3.4 Simple georeferencing of remotely sensed data
   3.5 Photogrammetric orientation and georeferencing

**Augmented Reality**

1. Augmented Reality (AR) – an introduction
   1.1 Can reality be upgraded?
   1.2 Definition of AR
   1.3 Delimitation to virtual reality
   1.4 Application of Augmented Reality
2. Functions of Augmented Reality
   2.1 Perceived reality
   2.2 Computer generated reality
   2.3 Upgraded reality
3. Augmented Reality Systems (ARS)
   3.1 Architecture of ARS
   3.2 Imaging
   3.3 Positioning, sight and tracking procedures
   3.4 Forms of representation
   3.5 Software solutions
   3.6 AR-Applications
3.7 Software development
4. Technical components for augmented reality
4.1 Automated image recognition
4.2 Forms of representation
4.3 Stationary Systems
4.4 Mobile Devices
5. Augmented Reality-examples
5.1 QR-Code based AR
5.2 GIS and AR
6. Augmented Reality in the practice
6.1 Current/ up-to-date fields of application
6.2 Potential of augmented Reality
6.3 Boundaries of augmented Reality
7. Future applications of Augmented Reality
8. Outlook connector and repetition

**Test type**
Written exam of 90 minutes

**Methods**
Seminars with exercises

**Literature**
Module: Mandatory elective 1

Module number: 0-72
Module responsible: Prof. Dr. Wolfgang Dorner
Course specialization: Mobile and spatial systems
Course number and course name: O6126 Mandatory elective 1 MRS
Semester: 6
Length of the Module: 1 Semester
Module frequency:

Course Type: elective
SWS: 4.0
ECTS: 5.0
Workload:
- Attendance: 60.0 hours
- Independent study: 90.0 hours
- Virtual share: 150.0 hours
- Total: 300.0 hours

Teaching-/Course language: German

Objectives
Complement the content of the studies in the field of the courses offered as electives

O6126 Mandatory elective 1 MRS

Course focus
Mobile and spatial systems

Objectives
Complement the content of the studies in the field of the courses offered as electives

Content
Description of the chosen elective

Test Type
Written exam of 90 minutes
Module: Mandatory elective 2

Module number 0-73
Module responsible Prof. Dr. Wolfgang Dorner
Course specialization Mobile and spatial systems
Course number and course name O7121 Mandatory elective 2 MRS
Semester 7
Length of the Module 1 Semester
Module frequency elective
Course type elective
SWS 4.0
ECTS 5.0
Workload
Attendance: 60.0 hours
Independent study: 90.0 hours
Virtual share: 150.0 hours
Total: 300.0 hours

Teaching-/Course language German

Objectives
Complement the content of the studies in the field of the courses offered as electives

O7121 Mandatory elective 2 MRS

Course focus
Mobile and spatial systems

Objectives
Complement the content of the studies in the field of the courses offered as elective

Content
To be found in the description of the chosen elective

Test Type
Written exam of 90 minutes
Module: Mandatory elective 3

Module number: 0-74
Module responsible Prof. Dr. Wolfgang Dorner
Course specialization Mobile and spatial systems
Course number and course name 07122 Mandatory elective 3 MRS
Semester 7
Length of the Module 1 Semester
Module frequency
Course type elective
SWS 4.0
ECTS 5.0
Workload Attendance: 60.0 hours
Independent study: 90.0 hours
Virtual share: 150.0 hours
Total: 300.0 hours

Teaching-/Course language German

Objectives
Complement the content of the studies in the field of the courses offered as electives

O7122 Mandatory elective 3 MRS

Course focus
Mobile and spatial systems

Objectives
Complement the content of the studies in the field of the courses offered as elective

Content
To be found in the description of the chosen elective

Test Type
Written exam of 90 minutes