

**Technology**  
**Arts Sciences**  
**TH Köln**

Faculty of Information, Media and Electrical Engineering

## **Master Computer Science and Engineering 2020**

### **Module Manual**

Version: 3.10.2025-08-29-11-03-34

The most recent version of this handbook can be found here:

<https://f07-studieninfo.web.th-koeln.de/mhb/current/en/MaTIN2020.html>

# 1. Program Description

Digitalization affects all areas of life: From toys and smartphones to cars and homes, there is hardware and software. Everyday processes such as shopping or pure communication are digitally permeated. A deep understanding of basic technology in all its breadth and depth, including theoretical models, communication and interaction possibilities as well as hardware and software architectures and intelligent, self-learning systems, is therefore becoming increasingly important.

## Orientation of the degree program

The application-oriented Master's degree course in Computer Engineering is designed for a standard period of study of 3 semesters. The course builds consecutively on the Bachelor's degree in Computer Engineering. Computer Engineering. However, it is also suitable as a second course of study to a Bachelor's degree in Computer Science, Electrical Engineering or Media Technology. Students gain in-depth knowledge and understanding of advanced understanding of advanced concepts, methods and technologies in computer science and IT-related communication technology. They will advance to the current state of the art. A high proportion of practical work and projects ensures that students can relate what they have learned in the individual subjects to each other and use it to solve challenging practical and theoretical problems. theoretischer Probleme einsetzen können.

## Occupational fields

The career prospects and future opportunities for computer engineering graduates are very good. In this respect, students with a good degree lay a promising foundation for their career. career. Graduates of the course are particularly predestined for planning, development and management tasks. They have access to a wide range of fields of activity both in companies in the information and communication technology companies, in related fields such as the automotive industry and automation technology as well as with service providers such as banks and insurance companies. Graduates with a Master of Science degree can also go on to study for a doctorate or take up a position in the senior civil service of public institutions. public institutions. Course of study The 3-semester course initially teaches in-depth specialist knowledge in theoretical computer science, computer engineering, mathematics and interdisciplinary skills and soft skills. competencies and soft skills. Specialization is achieved through the individual combination of nine elective modules from various disciplines of Computer Engineering and other computer science and communication technology disciplines. These subjects provide an in-depth knowledge and understanding of the advanced concepts, methods and technologies of the chosen disciplines. chosen disciplines. In this way, students can shape the subject focus of their studies according to their personal interests. Active participation in a current research project in a current research project at the institute is firmly anchored in the course. Here, students practice the scientifically sound analysis and solution of novel problems. The degree program concludes with the completion of a Master's thesis: methods and techniques of scientific work are applied independently to a challenging task.

Alongside the course, professional further training is offered to become a Cisco Certified Network Associate Security (CCNA Security).

## 2. Graduate Profile

Graduates of the M. Sc. Computer Science and Engineering degree program have in-depth scientific and methodological skills in the design, analysis and development of complex IT systems. In contrast to the Bachelor's degree program, the focus is on research, innovation, leadership and management skills as well as the cross-system application of IT technologies. You will be able to independently take responsibility for challenging projects in development, research or management and actively shape technological transformation processes.

The Master's degree program in Computer Science and Engineering is aimed at graduates with a sound first degree in computer science and deepens their knowledge in the field of software, hardware, distributed systems, AI, signal processing and communication technology.

Compared to the Bachelor's degree course, which focuses on the broad teaching of technical fundamentals and applications, the Master's degree focuses on:

- Scientific work and research-related project development
- Individual specialization through elective modules
- Interdisciplinary systems thinking
- Leadership and innovation skills

Graduates of the Master's degree program develop an individual profile in the following areas:

- You are proficient in the development, analysis and evaluation of complex IT systems, taking into account technical, social, legal and ecological framework conditions.
- You will be qualified for management tasks in research and development projects, including the management of interdisciplinary and international teams.
- Through intensive project work and the research project, you will acquire the ability to work independently on challenging issues with scientific depth.
- They can independently develop technical innovations in areas such as distributed systems, AI, embedded systems, network technologies and multimedia communication and transfer them into industrial or scientific applications.
- You will be able to contribute to the advancement of knowledge in computer science through scientific work and qualify for a doctorate.
- In addition to technical skills, the course also promotes self-organization, ethical judgement and intercultural communication skills - key requirements in modern technology professions.
- There are a wide range of professional fields: from technology development in industry, IT strategy and consulting to research at universities, institutes and public institutions.

### 3. Fields of Action

Central fields of activity in the degree program are development and design, research and innovation, leadership and management as well as quality assurance and testing. The profile module matrix shows which fields of activity are addressed by which modules.

#### **Development and Design**

Interdisciplinary development and testing of algorithms, circuits, software, devices, communication and media technology systems as well as complex computer, communication and embedded systems.

#### **Research and innovation**

Perform scientific research work and apply and expand scientific knowledge, from basic research to industrial research, with the qualification for doctoral studies.

#### **Leadership and management**

Assume technical leadership and project responsibility, including the coordination and management of working groups and internationally distributed teams, as well as the management of planning and manufacturing processes, project controlling and product management.

#### **Quality assurance and testing**

Carrying out quality controls and tests for products and processes, using measurement and testing technologies and coordinating certification processes.

## 4. Competencies

The modules of the degree program train students in different competencies, which are described below. The [Profile Module Matrix] (#Module Matrix) shows which competences are addressed by which modules.

### **Development and design of complex systems**

Ability to design and implement large systems, taking into account electrical, software, mechanical and optical aspects, based on a thorough requirements analysis from a technical, economic, ecological and social point of view.

### **Testing and evaluation of complex systems**

Plan, perform and analyze tests to verify and validate these systems, including consideration of user perspectives and technical-economic aspects.

### **Scientific work and research**

Mastery and application of scientific methods, including the ability to research, evaluate and cite relevant literature, and to formulate and present results.

### **Project management and teamwork**

Skills in organizing, managing and supervising projects and teams, even under uncertain conditions, and in making professional and organizational decisions.

### **Self-organization and self-taught skills**

Identification of personal skills, efficient time management and the ability for self-directed learning.

### **Communication and intercultural competence**

Ability to present and defend scientific and technical results convincingly in both German and English, including international and interdisciplinary contexts.

### **Technical and scientific fundamentals**

Comprehensive and in-depth STEM subject knowledge and its application to real-world and theoretical problems.

### **Sustainability and social responsibility**

Evaluate and develop sustainable and socially responsible technologies, including consideration of ethical values.

### **Analysis, simulation and abstraction**

Ability to analyze complex systems, abstract key features and solve problems based on models.

### **Leadership and decision-making responsibility**

Assume responsibility in technical management tasks, develop solution strategies for complex tasks.

### **Applying ethical values and principles in practice**

Incorporating social and ethical considerations into technical decisions and design processes.

### **Integrative thinking and acting in interdisciplinary teams**

Coordinating and integrating contributions from different disciplines to solve complex tasks.

### **Innovation and creativity**

Developing new solutions and concepts to overcome technical challenges.

## 5. Study Plans

The following are studyable study plans. Other study plans are also possible. Please note, however, that each module is usually only offered once a year. Please also note that several modules may have to be selected in a particular semester and elective catalogs in order to obtain the total ECTS credit points shown.

### 5.1 Regelstudium, Bsp. Beginn Sommersemester

| Sem. | Abbr. | Module Name                                   | Mandatory (PF)<br>Elective<br>Catalog (WB) | ECTS |
|------|-------|-----------------------------------------------|--------------------------------------------|------|
| 1    | THI   | Theoretische Informatik                       | PF                                         | 5    |
|      | VMT   | Vertiefung Mathematik                         | WB                                         | 5    |
|      | VTI   | Vertiefung Technische Informatik              | WB                                         | 5    |
|      | W     | Allgemeiner Wahlbereich                       | WB                                         | 10   |
|      | X     | Fachübergreifende Kompetenzen und Soft Skills | WB                                         | 5    |
| 2    | FP    | Forschungsprojekt                             | PF                                         | 10   |
|      | VTI   | Vertiefung Technische Informatik              | WB                                         | 10   |
|      | W     | Allgemeiner Wahlbereich                       | WB                                         | 10   |
| 3    | MAA   | Masterarbeit                                  | PF                                         | 27   |
|      | KOLL  | Kolloquium zur Masterarbeit                   | PF                                         | 3    |

**5.2 Studienverlauf mit vermindertem Workload; Bsp. Beginn Sommersemester**

| Sem. | Abbr. | Module Name                                   | Mandatory (PF)<br>Elective<br>Catalog (WB) | ECTS |
|------|-------|-----------------------------------------------|--------------------------------------------|------|
| 1    | THI   | Theoretische Informatik                       | PF                                         | 5    |
|      | VMT   | Vertiefung Mathematik                         | WB                                         | 5    |
|      | VTI   | Vertiefung Technische Informatik              | WB                                         | 5    |
| 2    | VTI   | Vertiefung Technische Informatik              | WB                                         | 5    |
|      | W     | Allgemeiner Wahlbereich                       | WB                                         | 5    |
|      | X     | Fachübergreifende Kompetenzen und Soft Skills | WB                                         | 5    |
| 3    | VTI   | Vertiefung Technische Informatik              | WB                                         | 5    |
|      | W     | Allgemeiner Wahlbereich                       | WB                                         | 10   |
| 4    | FP    | Forschungsprojekt                             | PF                                         | 10   |
|      | W     | Allgemeiner Wahlbereich                       | WB                                         | 5    |
| 5    | MAA   | Masterarbeit                                  | PF                                         | 27   |
| 6    | MAA   | Masterarbeit                                  | PF                                         | 27   |
|      | KOLL  | Kolloquium zur Masterarbeit                   | PF                                         | 3    |

## 6. Modules

The modules of the degree program are described below in alphabetical order.

### 6.1 ACC - Advanced Channel Coding

|                             |                                              |
|-----------------------------|----------------------------------------------|
| <b>Module ID</b>            | ACC_MaTIN2020                                |
| <b>Module Name</b>          | Advanced Channel Coding                      |
| <b>Type of Module</b>       | Elective Modules                             |
| <b>Recognized Course</b>    | ACC - Advanced Channel Coding                |
| <b>ECTS credits</b>         | 5                                            |
| <b>Language</b>             | englisch                                     |
| <b>Duration of Module</b>   | 1 Semester                                   |
| <b>Recommended Semester</b> | 1-2                                          |
| <b>Frequency of Course</b>  | every summer term                            |
| <b>Module Coordinator</b>   | Prof. Dr. Uwe Dettmar/Professor Fakultät IME |
| <b>Lecturer(s)</b>          | Prof. Dr. Uwe Dettmar/Professor Fakultät IME |

#### Learning Outcome(s)

What? Designing and rating of systems for the reliable transmission of data over distorted channels and storage of data for data at rest and data in motion

How? By applying results from information theory and applying methods and algorithms for error correcting codes using existing simulations tools, self written programmes, and studying existing systems.

What for? To be able to design, select, use and apply actual and future digital communication systems for reliable data transmission, and to rate their performance.

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## Module Contents

### Lecture / Exercises

The underlying concept of this module is a combination from lecture and tutorial. After a lecture block of approximately 20 minutes) the subjects taught are actively trained using Matlab/Octave and Python programs.

Syllabus:

- Introduction
- Basic terms and definitions
- short history of channel coding
- System and channel models
- Review of binary error correcting block and convolutional Codes
- Generator and Parity check matrices,
- decoding principles, Trellis and Viterbi Algorithm
- Some principles on Information Theory
- Channel coding theorem
- Channel capacity and example calculations
- Cyclic Codes, Reed Solomon Codes
- Encoding and Decoding, Euklidean and Berlekamp-Massey -Algorithm for Decoding
- Basics on LDPC, Polar, and TURBO Codes
- iterative decoding, Sum Product Algorithm
- Recursive Convolutional Codes
- Performance comparison
- Basics on Space Time Coding
- Channel Model, Capacity improvement, Alamouti Scheme, STBC and STTC and their decoding

These subjects are presented during the lecture. Students shall deepen their knowledge by self-study of literature and internet ressources and discuss their results in small learning groups as a teamwork.

By the help of small exercises and programs during the presence time, students are able to actively train their knowledge. More extensive problems are solved and discussed in the second part of the course to activate the student's capabilities to solve relevant problems.

Students further learn

- to analyze communication systems and to estimate their performance
- to compare and rate algorithms and methods
- to apply their knowledge to technical problems

### Lab

Existing simulation Tools like, e.g., the Matlab Communications Toolbox or AFF3CT ([aff3ct.github.io](https://aff3ct.github.io)) are used to:

- test theoretical results from lecture and tutorial
- implement algorithms for error control coding
- simulate BER and rate the performance, compare schemes
- adapt programs to solve equivalent problems
- become familiar with standard simulations tools
- train cooperation in small teams

Students learn to generate, check, present, and discuss performance results for FEC codes. They need to search for and to study scientific literature as background sources for their simulations. Teams of students get different code families to study. Results are presented to the whole group.

|                              |                       |
|------------------------------|-----------------------|
| <b>Teaching and Learning</b> | ▪ Lecture / Exercises |
| <b>Methods</b>               | ▪ Lab                 |

|                                       |                      |
|---------------------------------------|----------------------|
| <b>Examination Types with Weights</b> | cf. exam regulations |
|---------------------------------------|----------------------|

|                 |           |
|-----------------|-----------|
| <b>Workload</b> | 150 Hours |
|-----------------|-----------|

|                      |                      |
|----------------------|----------------------|
| <b>Contact Hours</b> | 45 Hours $\pm$ 4 SWS |
|----------------------|----------------------|

|                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Self-Study</b>                                | 105 Hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Recommended Prerequisites</b>                 | <ul style="list-style-type: none"><li>▪ Modul HIM: Grundkenntnisse zur linearen Algebra, der Algebra in endlichen Zahlkörpern, der Stochastik und der digitalen Kommunikationstechnik aus den vorangegangenen Bachelorstudiengängen. Da das Fach im ersten Fachsemester des Masters gewählt werden kann, können keine belastbaren Kenntnisse aus dem Fach HIM verpflichtend vorausgesetzt werden, auch wenn sie hilfreich wären.</li><li>▪ basics in linear algebra</li><li>▪ basics in stochastics</li><li>▪ good programming skills</li></ul>                                                                       |
| <b>Mandatory Prerequisites</b>                   | <ul style="list-style-type: none"><li>▪ Lab requires attendance in the amount of: 2 Praktikumstermine und 1 Präsentation</li><li>▪ Participation in final examination only after successful participation in Lab</li></ul>                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Recommended Literature</b>                    | <ul style="list-style-type: none"><li>▪ R. E. Blahut. Algebraic Codes for Data Transmission. Cambridge University Press, Cambridge, 2003.</li><li>▪ S. Lin and D. J. Costello. Error Control Coding. ISBN 0-13-042672-5. Prentice-Hall, 2004</li><li>▪ T. M. Cover and J. A. Thomas. Elements of Information Theory. Wiley, New Jersey, 2006</li><li>▪ A. Neubauer. Kanalcodierung. Schlembach, Wilburgstetten, 2006.</li><li>▪ R. Roth. Introduction to Coding Theory. Cambridge, second edition, 2006</li><li>▪ B. Sklar. Digital Communications. Prentice Hall PTR, Upper Saddle River, New Jersey, 2001</li></ul> |
| <b>Use of the Module in Other Study Programs</b> | <ul style="list-style-type: none"><li>▪ ACC in Master Communication Systems and Networks 2020</li><li>▪ ACC in Master Communication Systems and Networks 2024</li><li>▪ ACC in Master Informatik und Systems-Engineering 2024</li></ul>                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Permanent Links to Organization</b>           | <a href="#">ILU course page</a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Specifics and Notes</b>                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Last Update</b>                               | 19.7.2025, 14:32:16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |

## 6.2 AMC - Advanced Multimedia Communications

|                             |                                                |
|-----------------------------|------------------------------------------------|
| <b>Module ID</b>            | AMC_MaTIN2020                                  |
| <b>Module Name</b>          | Advanced Multimedia Communications             |
| <b>Type of Module</b>       | Elective Modules                               |
| <b>Recognized Course</b>    | AMC - Advanced Multimedia Communications       |
| <b>ECTS credits</b>         | 5                                              |
| <b>Language</b>             | englisch                                       |
| <b>Duration of Module</b>   | 1 Semester                                     |
| <b>Recommended Semester</b> | 1-2                                            |
| <b>Frequency of Course</b>  | every winter term                              |
| <b>Module Coordinator</b>   | Prof. Dr. Andreas Grebe/Professor Fakultät IME |
| <b>Lecturer(s)</b>          | Prof. Dr. Andreas Grebe/Professor Fakultät IME |

### Learning Outcome(s)

What?

Understanding service requirements, driven by heterogeneous services, in All-IP networks, and how to design, implement and evaluate quality-of-service (QoS) and quality-of-experience (QoE) mechanisms. Competences to evaluate, analyze, design, implement and test multiservice IP networks with heterogeneous service requirements.

How?

Based on Bachelor-level competences on IP networking and services, students learn different application (service) requirements from filetransfer to streaming and how to separate and fulfill these requirements in IP networks. In a small team and organized as semester project, students develop their own multiservice networks, optionally based on existing systems, and learn how to design, implement and analyze their own multiservice network solution.

What for?

To be able to design, analyze, select, use and apply actual and future network technologies, based on All-IP networks concepts for enterprise networks, telecommunication networks and mobile networks.

### Module Contents

#### Lecture / Exercises

Content for multimedia applications, encoding of multimedia data, integration of data, audio and video, multimedia traffic requirements, multimedia transport protocols, RTP and MPEG-TS, traffic modeling burst silence model, quality of service (QoS), multiservice networks, IntServ, RSVP, DiffServ, ToS and DSCP, Traffic Classification, Traffic Measurement, Traffic Shaping, Network Scheduling, Queueing (FIFO, RR, WRR, WFQ, CB-WFQ, PQ, LLQ), Congestion Avoidance (RED, WRED, CB-WRED), Quality-of-Experience (QoE), MOS Scale, Error Detection, Error Correction, FEC, Interleaving, Jitter Buffer.

Students evaluate technologies and network architectures of multiservice networks; they analyze requirements of Multimedia services and systems, design architectures for multiservice networks, implement multiservice networks, and analyze Multimedia communication protocols and their performance metrics.

#### Lab

Fundamental knowledge of multiservice networks or multimedia applications in All-IP networks including planning, implementation and evaluation of services. Protocol analysis for functional analysis, performance analysis and troubleshooting.

Students evaluate requirements of Multimedia services, and necessary methods for QoS in multiservice networks. They plan and implement IP Multimedia environments as team project, and test QoS performance measures. They are competent in functional analysis and troubleshooting by deep packet inspection (DPI) protocol analysis. They evaluate the performance of the Multimedia network or services in terms of timing, throughput, latency and delays, jitter, robustness in case of packet errors, and security aspects. Individual project proposals by students are welcome.

|                                      |                                                                                        |
|--------------------------------------|----------------------------------------------------------------------------------------|
| <b>Teaching and Learning Methods</b> | <ul style="list-style-type: none"> <li>■ Lecture / Exercises</li> <li>■ Lab</li> </ul> |
|--------------------------------------|----------------------------------------------------------------------------------------|

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|--------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Examination Types with Weights</b>            | cf. exam regulations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Workload</b>                                  | 150 Hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Contact Hours</b>                             | 45 Hours $\pm$ 4 SWS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Self-Study</b>                                | 105 Hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Recommended Prerequisites</b>                 | <ul style="list-style-type: none"> <li>▪ Modul NGN: Fundamentals of Networks and Protocols (typically Bachelor Level, like prerequisites in NGN) Layered Communications and Protocol Stacks (ISO/OSI, IETF TCP/IP, IEEE), LAN, MAN, WAN, Fixed Line and Mobile Network Fundamentals, Data Link-Technologies (Ethernet, WiFi), IP-Networking (IPv4, IPv6), IP Routing Protocols (static Routes, RIP, OSPF, BGP), Transport Protocols (TCP (incl. Flow Control / Congestion Control), UDP) and Port Numbers, Application Protocols (HTTP, Request-Response Pattern, Publish-Subscribe Pattern).</li> <li>▪ Bachelor-level knowledge of protocols and layer models, Internet protocols (UDP, TCP, IP, HTTP, FTP), IP addressing (IPv4, IPv6), routing techniques (IP routing, functionality of a router, routing protocols, RIP, OSPF), transmission systems and layer 2 protocols, Ethernet.</li> </ul> <p>Understanding distributed systems and applications, sockets and client/server programming, request-response patterns, publishg-subscribe patterns.</p> |
| <b>Mandatory Prerequisites</b>                   | <ul style="list-style-type: none"> <li>▪ Lab requires attendance in the amount of: 6 Meilensteintermine und Projektvorstellungen</li> <li>▪ Participation in final examination only after successful participation in Lab</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Recommended Literature</b>                    | <ul style="list-style-type: none"> <li>▪ J. Kurose, K. Ross: Computer Networking: A Top-Down Approach, Global Edition, Prentice Hall, 7th ed., 2016</li> <li>▪ A. S. Tanenbaum, D. J. Wetherall: Computer Networks, Pearson , 5th ed., 2013</li> <li>▪ W. Stallings: Foundations of Modern Networking, Pearson Education, 2016</li> <li>▪ H. W. Barz, G. A. Bassett: Multimedia Networks, John Wiley &amp; Sons, 2016</li> <li>▪ T. Szigeti, C. Hattingh, R. Barton, B. Kenneth: End-to-End QoS Network Design: Quality of Service for Rich-Media &amp; Cloud Networks (2nd Edition) End-to-End QoS Network Design: Quality of Service for Rich-Media &amp; Cloud Networks, Cisco Press, 2nd Ed. 2013</li> <li>▪ R. Steinmetz, K. Nahrstedt: „Multimedia Systems“, Springer 2004</li> <li>▪ R. Steinmetz, „Multimedia-Technologie“, Springer 2000</li> </ul>                                                                                                                                                                                                    |
| <b>Use of the Module in Other Study Programs</b> | <ul style="list-style-type: none"> <li>▪ AMC in Master Communication Systems and Networks 2020</li> <li>▪ AMC in Master Communication Systems and Networks 2024</li> <li>▪ AMC in Master Informatik und Systems-Engineering 2024</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Specifics and Notes</b>                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Last Update</b>                               | 19.7.2025, 14:32:16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

### 6.3 AMS - Special Aspects of Mobile Autonomous Systems

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------|
| <b>Module ID</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | AMS_MaTIN2020                                                                  |
| <b>Module Name</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Special Aspects of Mobile Autonomous Systems                                   |
| <b>Type of Module</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Elective Modules                                                               |
| <b>Recognized Course</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | AMS - Special Aspects of Mobile Autonomous Systems                             |
| <b>ECTS credits</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 5                                                                              |
| <b>Language</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | englisch                                                                       |
| <b>Duration of Module</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 1 Semester                                                                     |
| <b>Recommended Semester</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 1-2                                                                            |
| <b>Frequency of Course</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | every winter term                                                              |
| <b>Module Coordinator</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Prof. Dr. Chunrong Yuan/Professor Fakultät IME                                 |
| <b>Lecturer(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | Prof. Dr. Chunrong Yuan/Professor Fakultät IME                                 |
| <b>Learning Outcome(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                |
| <p>Was: Das Modul vermittelt Kompetenzen zur Entwicklung von mobilen autonomen Systemen, insbesondere im Themenbereich der räumlichen Interpretation und Kognition für die sichere Navigation von unbemannten Roboter- und Fahrzeugsystemen sowie intelligente Interaktion und Kollaboration unter Menschen und Robotern.</p> <p>Womit: Die Dozentin vermittelt Wissen und Basisfertigkeiten in einem Vorlesungsteil und betreut parallel dazu praktische Projekte, wobei die Studierenden mittels forschenden Lernens technische Ansätze studieren und erproben, Prototypen aufbauen und testen, Ergebnisse präsentieren, sowohl technische als auch ethische und soziale Aspekte diskutieren, und das Ganze schriftlich dokumentieren.</p> <p>Wozu: Kompetenzen in der Entwicklung von mobilen autonomen Systemen sind essentiell für technische Informatiker*innen und Nachwuchs in verwandten Ingenieurberufen. Derartige Kompetenzen sind unentbehrlich für die Forschung, Entwicklung sowie technische Innovation. Das projektbasierte und forschende Lernen im Team hilft den Studierenden außerdem, sich mit relevanten ethischen und sozialen Aspekten zu beschäftigen, welche im Zusammenhang mit autonomen Systemen stehen.</p> |                                                                                |
| <b>Module Contents</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                |
| <b>Lecture</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                |
| <p>Mobile autonomous systems</p> <p>Cognitive and behaviour-based robotics</p> <p>Environmental modelling and spatial cognition</p> <p>Interaction and navigation</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                |
| <b>Project</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                |
| <p>Teamwork: Development of autonomous systems with cognitive capabilities and intelligent behaviours.</p> <p>Such cognitive capabilities include e.g.: Recognize objects with sensors, estimate their locations or movements, make 3D representations and interpretations or build a map of the environment etc.</p> <p>Intelligent behaviours can be demonstrated among others by such actions: Move and navigate autonomously without collision in unknown environments, fetch or transport objects for a special application, nature interactions and collaborations among human and robots.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                |
| <b>Teaching and Learning Methods</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <ul style="list-style-type: none"> <li>▪ Lecture</li> <li>▪ Project</li> </ul> |
| <b>Examination Types with Weights</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | cf. exam regulations                                                           |
| <b>Workload</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 150 Hours                                                                      |
| <b>Contact Hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 34 Hours $\pm$ 3 SWS                                                           |
| <b>Self-Study</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 116 Hours                                                                      |

|                                                  |                                                                                                  |
|--------------------------------------------------|--------------------------------------------------------------------------------------------------|
| <b>Recommended Prerequisites</b>                 | Capability of software and project development<br>Knowledge of signal processing and mathematics |
| <b>Mandatory Prerequisites</b>                   | Project requires attendance in the amount of: 1 Präsentation                                     |
| <b>Recommended Literature</b>                    | ▪ Siegwart et.al.: Introduction to autonomous mobile robots, MIT Press, 2010                     |
| <b>Use of the Module in Other Study Programs</b> | AMS in Master Informatik und Systems-Engineering 2024                                            |
| <b>Specifics and Notes</b>                       |                                                                                                  |
| <b>Last Update</b>                               | 19.7.2025, 14:32:16                                                                              |

## 6.4 ARP - Alternative Rechnerarchitekturen und Programmiersprachen

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Module ID</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | ARP_MaTIN2020                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Module Name</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Alternative Rechnerarchitekturen und Programmiersprachen                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Type of Module</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Elective Modules                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Recognized Course</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | ARP - Alternative Computer Architectures and Programming Languages                                                                                                                                                                                                                                                                                                                                                                          |
| <b>ECTS credits</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 5                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Language</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | deutsch                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Duration of Module</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1 Semester                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Recommended Semester</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 1-2                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Frequency of Course</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | every winter term                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Module Coordinator</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Prof. Dr. René Wörzberger/Professor Fakultät IME                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Lecturer(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Prof. Dr. Georg Hartung/Professor Fakultät IME im Ruhestand                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Learning Outcome(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Die Studierenden lernen kennen, wenden an und analysieren verschiedene wichtige Konzepte von Rechnerarchitekturen und Programmiersprachen. Dazu wenden sie für jedes ausgewählte Konzept nach einer kurzen Vorstellung es auf ein selbstgewähltes Beispiel an, wozu sie sich weiteres Wissen über das Konzept erwerben müssen, und analysieren die Vor- und Nachteile des Konzepts in einem Bericht. Damit erlangen sie einen größeren Überblick über verfügbare Architekturen und Programmiersprachen für ihre spätere Tätigkeit als IT-Spezialist, Manager oder in der Forschung. |                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Module Contents</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Lecture / Exercises</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Knowledge of the respective modeling method, programming procedure or architecture and its programming ("Topics"); practice of initial Topic skills in exercises.                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Project</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| Application of the topic to a self-selected task, analysis of the features of the topic on a concrete example, synthesis with own experiences, teamwork (processing in a small group)                                                                                                                                                                                                                                                                                                                                                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Teaching and Learning Methods</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <ul style="list-style-type: none"> <li>▪ Lecture / Exercises</li> <li>▪ Project</li> </ul>                                                                                                                                                                                                                                                                                                                                                  |
| <b>Examination Types with Weights</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | cf. exam regulations                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Workload</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 150 Hours                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Contact Hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 45 Hours $\triangleq$ 4 SWS                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Self-Study</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 105 Hours                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Recommended Prerequisites</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | <ul style="list-style-type: none"> <li>- Experience in imperative programming languages, esp. C</li> <li>- Basic knowledge and experience in operating systems, esp. Linux</li> <li>- Basic knowledge and experience in software engineering</li> <li>- Basic knowledge of computer design and operation, including operation of important digital components</li> <li>- Basic knowledge of formal languages and automata theory</li> </ul> |
| <b>Mandatory Prerequisites</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Project requires attendance in the amount of: 4 Termine                                                                                                                                                                                                                                                                                                                                                                                     |

**Recommended Literature**

- Jensen, K., Kristensen, L.M.: Coloured Petri Nets
- Nilsson, U.; Maluszynski, J.: Logic, Programming and Prolog
- T. Eiter, G. Ianni, T. Krennwallner: 'Answer Set Programming: A Primer' in: Reasoning WEB Semantic Technologies for Information Systems
- Steve Klabnik and Carol Nichols: The Rust Programming Language
- William Gropp et al.: Using Advanced MPI / Modern Features of the Message Passing Interface, MIT Press
- Gerassimos Barlas Multicore and GPU Programming - An Integrated Approach Morgan Kaufmann Publ., Inc.

**Use of the Module in Other Study Programs**

ARP in Master Informatik und Systems-Engineering 2024

**Specifics and Notes****Last Update**

19.7.2025, 14:32:16



## 6.5 AVT - Audio- und Videotechnologien

|                             |                                                      |
|-----------------------------|------------------------------------------------------|
| <b>Module ID</b>            | AVT_MaTIN2020                                        |
| <b>Module Name</b>          | Audio- und Videotechnologien                         |
| <b>Type of Module</b>       | Elective Modules                                     |
| <b>Recognized Course</b>    | AVT - Audio and Video Technologies                   |
| <b>ECTS credits</b>         | 5                                                    |
| <b>Language</b>             | deutsch, englisch bei Bedarf                         |
| <b>Duration of Module</b>   | 1 Semester                                           |
| <b>Recommended Semester</b> | 1-2                                                  |
| <b>Frequency of Course</b>  | every winter term                                    |
| <b>Module Coordinator</b>   | Prof. Dr.-Ing. Klaus Ruelberg/Professor Fakultät IME |
| <b>Lecturer(s)</b>          | Prof. Dr.-Ing. Klaus Ruelberg/Professor Fakultät IME |

### Learning Outcome(s)

Was:

Audio- und Videotechnologien kommen in vielfältiger Weise in der Medienindustrie zum Einsatz. Die Mediendistributionskette, die im Rahmen der LV als exemplarische Anwendung herangezogen und analysiert wird, umfasst verschiedene Technologien wie Datenkompression, Audio- und Videosignalverarbeitung, Fehlerschutzmechanismen, digitale Modulationsverfahren.

Womit:

Studierende durchdringen eigenständig ausgewählte Themengebiete der Audio- und Videotechnologien, bereiten diese auf und halten einen Fachvortrag.

In einem in die LV integrierter Übungsblock entwickeln die Studierende eigenständig algorithmische Lösungskonzepte und setzen diese programmtechnisch um.

Wozu:

Die Studierenden können aktuelle Verfahren zur Audio- und Videocodierung entwickeln und in Hard- und Software implementieren. Sie können Mediendistributionsketten planen, beurteilen und umsetzen sowie fachliche Führungs- und Projektverantwortung übernehmen.

### Module Contents

#### Lecture / Exercises

Audio and video source coding

Channel models, channel coding (FEC & digital modulation principles)

Broadcast transmission systems (DVB - Digital Video Broadcasting)

implement audio and video coding methods in hard and software

develop algorithms and methods for audio and videocoding

develop and implement digital broadcasting systems

#### Exercises / Lab

|                                      |                                                                                                    |
|--------------------------------------|----------------------------------------------------------------------------------------------------|
| <b>Teaching and Learning Methods</b> | <ul style="list-style-type: none"> <li>■ Lecture / Exercises</li> <li>■ Exercises / Lab</li> </ul> |
|--------------------------------------|----------------------------------------------------------------------------------------------------|

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|---------------------------------------|----------------------|
| <b>Examination Types with Weights</b> | cf. exam regulations |
|---------------------------------------|----------------------|

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|-----------------|-----------|
| <b>Workload</b> | 150 Hours |
|-----------------|-----------|

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|----------------------|----------------------|
| <b>Contact Hours</b> | 57 Hours $\pm$ 5 SWS |
|----------------------|----------------------|

|                   |          |
|-------------------|----------|
| <b>Self-Study</b> | 93 Hours |
|-------------------|----------|

|                                  |      |
|----------------------------------|------|
| <b>Recommended Prerequisites</b> | none |
|----------------------------------|------|

|                                                  |                                                                                                                                                                                                                                           |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Mandatory Prerequisites</b>                   | Exercises / Lab requires attendance in the amount of: 1 Termin                                                                                                                                                                            |
| <b>Recommended Literature</b>                    | <ul style="list-style-type: none"><li>▪ Proakis, J. Salehi, M. (2007) Digital Communications. McGraw-Hill. ISBN 978-0072957167</li><li>▪ Reimers, U. (2001) Digital Video Broadcasting. Springer Verlag. ISBN 978-3-662-04562-6</li></ul> |
| <b>Use of the Module in Other Study Programs</b> | <ul style="list-style-type: none"><li>▪ AVT in Master Medientechnologie 2020</li><li>▪ AVT in Master Medientechnologie 2024</li><li>▪ AVT in Master Informatik und Systems-Engineering 2024</li></ul>                                     |
| <b>Specifics and Notes</b>                       |                                                                                                                                                                                                                                           |
| <b>Last Update</b>                               | 19.7.2025, 14:32:16                                                                                                                                                                                                                       |

## 6.6 CI - Computational Intelligence

|                             |                                                                                          |
|-----------------------------|------------------------------------------------------------------------------------------|
| <b>Module ID</b>            | CI_MaTIN2020                                                                             |
| <b>Module Name</b>          | Computational Intelligence                                                               |
| <b>Type of Module</b>       | Elective Modules                                                                         |
| <b>Recognized Course</b>    | CI - Computational Intelligence                                                          |
| <b>ECTS credits</b>         | 5                                                                                        |
| <b>Language</b>             | deutsch, englisch bei Bedarf                                                             |
| <b>Duration of Module</b>   | 1 Semester                                                                               |
| <b>Recommended Semester</b> | 1-2                                                                                      |
| <b>Frequency of Course</b>  | every winter term                                                                        |
| <b>Module Coordinator</b>   | Studiengangsleiter(in) Master Technische Informatik / Informatik und Systems-Engineering |
| <b>Lecturer(s)</b>          | Prof. Dr. Rainer Bartz/Professor Fakultät IME                                            |

### Learning Outcome(s)

Die Studierenden erarbeiten sich grundlegende Kenntnisse zur Theorie und Anwendung von Methoden der Computational Intelligence. Die Studierenden kennen die gängigen Typen von Optimierungsaufgaben und können konkrete Aufgaben einordnen. Die Studierenden kennen das Prinzip des Simplex-Algorithmus und können eine Problemstellung in die für ihn geeignete Standardform überführen und eine Lösung erarbeiten. Sie können lineare Probleme mit einem Simplex-Algorithmus lösen. Die Studierenden können neuronale Netze einordnen und ihre Anwendbarkeit auf Problemstellungen bewerten. Sie können Lernverfahren klassifizieren und ihre Arbeitsweise beschreiben. Sie können nichtlineare Probleme der Modellbildung und Klassifizierung mit einem neuronalen Netz lösen. Sie kennen die Methodik der Fuzzy Logik und können eine Problemstellung darauf abbilden und das resultierende Systemverhalten begründen. Sie können unscharf definierte Aufgaben mit Hilfe von Fuzzy Logik lösen. Die Studierenden kennen die Arbeitsweise evolutionärer Algorithmen und können ihre Varianten einordnen. Sie können reale Problemstellungen in geeignete Repräsentationen umsetzen. Sie können Selektionsverfahren bewerten und geeignete Selektionsalgorithmen entwerfen. Sie können schwierige Probleme mit Heuristiken der evolutionären Algorithmen lösen. Die Studierenden können mit üblichen Werkzeugen der Computational Intelligence umgehen. Die Studierenden können Aufgaben in einem kleinen Team lösen. Die Studierenden können Systemparameter variieren, Messreihen durchführen und Ergebnisse darstellen, bewerten und diskutieren. Sie können das Verhalten eines Systems bewerten und durch geeignete Modifikationen verbessern. Die Studierenden können internationale wissenschaftliche Literatur analysieren, einordnen, in ihren Kontext stellen und präsentieren.

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**Module Contents****Lecture / Exercises**

Optimization strategies

- classification of problems
- gradient algorithms
- simplex algorithm
- multiobjective optimization and Pareto approach

Artificial neural networks

- artificial neurons
- neural network structures
- training algorithms

Fuzzy logic

- fuzzification
- inference
- defuzzification

Evolutionary algorithms

- genome representations
- selection mechanisms
- recombination operators
- mutation operators

The students acquire fundamental knowledge on theory and applications of computational intelligence

The students know about typical classes of optimization tasks and how to map a specific problem to those classes

They know the simplex algorithm and can transform problems into the standard form to find the solutions

The students can classify artificial neural networks and determine their applicability for specific tasks

They can vary the parameters of neural networks and rate their impact on the results

They can classify training algorithms and understand the backpropagation algorithm

They know about the fuzzy logic approach, can apply it to specific problems and justify the resulting system behavior

The students know how evolutionary algorithms work and can distinguish the variants

They can transform a problem specification into a representation appropriate for an evolutionary algorithm

They can rate selection strategies and define suitable algorithms

The students can solve linear problems with the use of the simplex algorithm

They can apply artificial neural networks to solve problems of modeling and classification

They can define fuzzy logic systems to solve imprecise and vague tasks

They can solve difficult problems heuristically using evolutionary algorithms

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**Lab**

Application of artificial neural networks to a classification task

Variation and multiobjective optimization of neural network parameters

Fuzzy-based closed loop control of a system with two inputs

The students are familiar with tools supporting computational intelligence

The students can vary system parameters, perform test series, and evaluate, present and discuss the results

The students are able to understand, present, analyze and discuss scientific publications

The students are able to solve problems in small teams

They can tackle optimization tasks in a structured and systematic way

They can rate the behavior of a system with regard to objectives and study and improve the behavior through parameter variations

They are able to cope with international scientific publications, understanding, presenting and discussing them in their context

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|--------------------------------------|-------------------------------------------------------------------------------------|
| <b>Teaching and Learning Methods</b> | <ul style="list-style-type: none"><li>▪ Lecture / Exercises</li><li>▪ Lab</li></ul> |
|--------------------------------------|-------------------------------------------------------------------------------------|

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| <b>Examination Types with Weights</b> | cf. exam regulations |
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| <b>Workload</b> | 150 Hours |
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|----------------------|-----------------------------|
| <b>Contact Hours</b> | 45 Hours $\triangleq$ 4 SWS |
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|                   |           |
|-------------------|-----------|
| <b>Self-Study</b> | 105 Hours |
|-------------------|-----------|

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|                                  |                            |
|----------------------------------|----------------------------|
| <b>Recommended Prerequisites</b> | vector functions, gradient |
|----------------------------------|----------------------------|

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|                                |                                                     |
|--------------------------------|-----------------------------------------------------|
| <b>Mandatory Prerequisites</b> | Lab requires attendance in the amount of: 2 Termine |
|--------------------------------|-----------------------------------------------------|

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|                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Recommended Literature</b> | <ul style="list-style-type: none"><li>▪ Domschke W., Drexl A.: Einführung in Operations Research; Springer</li><li>▪ Zell, A.: Simulation Neuronaler Netze; Oldenbourg</li><li>▪ Nauck, D. et al.: Neuronale Netze und Fuzzy-Systeme; Vieweg</li><li>▪ Eiben, A.E., Smith, J.E.: Introduction to Evolutionary Computing; Springer</li><li>▪ Gerdes, I. et al.: Evolutionäre Algorithmen; Vieweg</li><li>▪ Grosse et al.: Taschenbuch der praktischen Regelungstechnik, Fachbuchverlag Leipzig</li></ul> |
|-------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

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|--------------------------------------------------|------------------------------------------------------|
| <b>Use of the Module in Other Study Programs</b> | CI in Master Informatik und Systems-Engineering 2024 |
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| <b>Specifics and Notes</b> |  |
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| <b>Last Update</b> | 19.7.2025, 14:32:16 |
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## 6.7 DLO - Deep Learning und Objekterkennung

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|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Module ID</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | DLO_MaTIN2020                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Module Name</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Deep Learning und Objekterkennung                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Type of Module</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Elective Modules                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Recognized Course</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | DLO - image processing master                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>ECTS credits</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Language</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | deutsch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Duration of Module</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | 1 Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Recommended Semester</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | 1-2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Frequency of Course</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | every summer term                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Module Coordinator</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Prof. Dr. Jan Salmen/Professor Fakultät IME                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Lecturer(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Prof. Dr. Jan Salmen/Professor Fakultät IME                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Learning Outcome(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <p>Die Teilnehmer*innen können selbständig entscheiden, in welchen Situationen sich der Einsatz von Verfahren aus dem Bereich Deep Learning anbietet. Sie können eine entsprechende Lösung entwerfen, iterativ verbessern und praktisch umsetzen. Mögliche Probleme auf dem Weg dahin (z.B. beim Erstellen eines Datensatzes oder beim Training) können sie qualifiziert analysieren und passende Ideen zur Bewältigung entwickeln. Da sie einen guten Überblick über die langjährigen Entwicklungen in Forschung und Technik haben, können sie qualifiziert auf aktuelle Herausforderungen und offene Fragen im Zusammenhang mit Deep Learning schauen. Die Studierenden werden so in die Lage versetzt, sich sowohl im weiteren Studienverlauf als auch im Berufsleben kompetent mit Ansätzen zu beschäftigen, die auf Deep Learning beruhen.</p> |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Module Contents</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Lecture</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| Deep learning algorithms and their application for object recognition in images.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Lab</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| training of a neural network<br>evaluation of the performance of a neural network                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Teaching and Learning Methods</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | <ul style="list-style-type: none"> <li>▪ Lecture</li> <li>▪ Lab</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Examination Types with Weights</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | cf. exam regulations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Workload</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 150 Hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Contact Hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | 34 Hours $\pm$ 3 SWS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Self-Study</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 116 Hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Recommended Prerequisites</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | The students should have some basic knowledge about image processing and pattern recognition                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Mandatory Prerequisites</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | Lab requires attendance in the amount of: 4 Termine                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Recommended Literature</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | <ul style="list-style-type: none"> <li>▪ I. Goodfellow, Y. Bengio und A. Courville. Deep Learning. MIT Press, 2016</li> <li>▪ C. C. Aggarwal. Neural Networks and Deep Learning: A Textbook. Springer, 2018</li> <li>▪ C. Bishop und H. Bishop. Deep Learning: Foundations and Concepts. Springer, 2024</li> <li>▪ D. V. Godoy. Deep Learning with PyTorch Step-by-Step: A Beginner's Guide. Fundamentals. 2022</li> <li>▪ D. V. Godoy. Deep Learning with PyTorch Step-by-Step: A Beginner's Guide. Computer Vision. 2022</li> </ul> |

|                                                      |                                                                                                                                                                                                                                                                                                                       |
|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Use of the Module in<br/>Other Study Programs</b> | <ul style="list-style-type: none"><li>▪ DLO in Master Elektrotechnik 2020</li><li>▪ DLO in Master Elektrotechnik und Informationstechnik 2024</li><li>▪ DLO in Master Medientechnologie 2020</li><li>▪ DLO in Master Medientechnologie 2024</li><li>▪ DLO in Master Informatik und Systems-Engineering 2024</li></ul> |
|------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

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**Specifics and Notes**

|                    |                     |
|--------------------|---------------------|
| <b>Last Update</b> | 19.7.2025, 14:32:16 |
|--------------------|---------------------|

## 6.8 DMC - Digital Motion Control

|                                                                                                                                                                                                                                                                                                                                                          |                                                                                    |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| <b>Module ID</b>                                                                                                                                                                                                                                                                                                                                         | DMC_MaTIN2020                                                                      |
| <b>Module Name</b>                                                                                                                                                                                                                                                                                                                                       | Digital Motion Control                                                             |
| <b>Type of Module</b>                                                                                                                                                                                                                                                                                                                                    | Elective Modules                                                                   |
| <b>Recognized Course</b>                                                                                                                                                                                                                                                                                                                                 | DMC - Digital Motion Control                                                       |
| <b>ECTS credits</b>                                                                                                                                                                                                                                                                                                                                      | 5                                                                                  |
| <b>Language</b>                                                                                                                                                                                                                                                                                                                                          | deutsch                                                                            |
| <b>Duration of Module</b>                                                                                                                                                                                                                                                                                                                                | 1 Semester                                                                         |
| <b>Recommended Semester</b>                                                                                                                                                                                                                                                                                                                              | 1-2                                                                                |
| <b>Frequency of Course</b>                                                                                                                                                                                                                                                                                                                               | every summer term                                                                  |
| <b>Module Coordinator</b>                                                                                                                                                                                                                                                                                                                                | Prof. Dr. Jens Onno Krah/Professor Fakultät IME                                    |
| <b>Lecturer(s)</b>                                                                                                                                                                                                                                                                                                                                       | Prof. Dr. Jens Onno Krah/Professor Fakultät IME                                    |
| <b>Learning Outcome(s)</b>                                                                                                                                                                                                                                                                                                                               |                                                                                    |
| <ul style="list-style-type: none"> <li>Servomotoren kennenlernen und betreiben</li> <li>Servoumrichter kennenlernen und verwenden</li> <li>Digitale Regelalgorithmen nutzen</li> <li>Prozessidentifikation und Parameterestimation</li> <li>Auslegung von Antriebssystemen</li> </ul>                                                                    |                                                                                    |
| <b>Module Contents</b>                                                                                                                                                                                                                                                                                                                                   |                                                                                    |
| <b>Lecture / Exercises</b>                                                                                                                                                                                                                                                                                                                               |                                                                                    |
| <ul style="list-style-type: none"> <li>Structure of servo motors</li> <li>Structure of servo inverters</li> <li>Digital control algorithms</li> <li>Process identification</li> <li>Design of drive systems</li> </ul>                                                                                                                                   |                                                                                    |
| <b>Lab</b>                                                                                                                                                                                                                                                                                                                                               |                                                                                    |
| <ul style="list-style-type: none"> <li>Direct Digital Control</li> <li>Quasi-continuous control</li> <li>Predictor / Observer</li> <li>Parameterization of a control system</li> <li>Evaluation of Bode diagrams</li> <li>Demonstrate action competence</li> <li>Commissioning of a servocontroller</li> <li>Minimization of following errors</li> </ul> |                                                                                    |
| <b>Teaching and Learning Methods</b>                                                                                                                                                                                                                                                                                                                     | <ul style="list-style-type: none"> <li>Lecture / Exercises</li> <li>Lab</li> </ul> |
| <b>Examination Types with Weights</b>                                                                                                                                                                                                                                                                                                                    | cf. exam regulations                                                               |
| <b>Workload</b>                                                                                                                                                                                                                                                                                                                                          | 150 Hours                                                                          |
| <b>Contact Hours</b>                                                                                                                                                                                                                                                                                                                                     | 45 Hours $\triangleq$ 4 SWS                                                        |
| <b>Self-Study</b>                                                                                                                                                                                                                                                                                                                                        | 105 Hours                                                                          |
| <b>Recommended Prerequisites</b>                                                                                                                                                                                                                                                                                                                         | RT, DSS                                                                            |



|                                                  |                                                                                                                                                                                                                                                                                                                                                                                                            |
|--------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Mandatory Prerequisites</b>                   | Lab requires attendance in the amount of: 3 Termine                                                                                                                                                                                                                                                                                                                                                        |
| <b>Recommended Literature</b>                    | <ul style="list-style-type: none"><li>▪ Krah, Jens Onno, Vorlesungsskript MC</li><li>▪ Krah, Jens Onno: Vorlesungsskript RT (Download)</li><li>▪ Handbuch ServoStar 300: <a href="http://www.danahermotion.net">www.danahermotion.net</a></li><li>▪ Schultz, G.: Regelungstechnik, Oldenbourg Verlag, München-Wien</li><li>▪ Lutz, Wendt: Taschenbuch der Regelungstechnik, Verlag Harri Deutsch</li></ul> |
| <b>Use of the Module in Other Study Programs</b> | <ul style="list-style-type: none"><li>▪ DMC in Master Elektrotechnik 2020</li><li>▪ DMC in Master Elektrotechnik und Informationstechnik 2024</li><li>▪ DMC in Master Informatik und Systems-Engineering 2024</li></ul>                                                                                                                                                                                    |
| <b>Specifics and Notes</b>                       |                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Last Update</b>                               | 19.7.2025, 14:32:16                                                                                                                                                                                                                                                                                                                                                                                        |

## 6.9 DSP - Digital Signal Processing

|                             |                                                     |
|-----------------------------|-----------------------------------------------------|
| <b>Module ID</b>            | DSP_MaTIN2020                                       |
| <b>Module Name</b>          | Digital Signal Processing                           |
| <b>Type of Module</b>       | Elective Modules                                    |
| <b>Recognized Course</b>    | DSP - Digital Signal Processing                     |
| <b>ECTS credits</b>         | 5                                                   |
| <b>Language</b>             | englisch                                            |
| <b>Duration of Module</b>   | 1 Semester                                          |
| <b>Recommended Semester</b> | 1-2                                                 |
| <b>Frequency of Course</b>  | every winter term                                   |
| <b>Module Coordinator</b>   | Prof. Dr. Harald Elders-Boll/Professor Fakultät IME |
| <b>Lecturer(s)</b>          | Prof. Dr. Harald Elders-Boll/Professor Fakultät IME |

### Learning Outcome(s)

Design, analyse and implement DSP systems in soft and hardware considering computational complexity and hardware resource limitation, by a thorough understanding of the theoretical concepts, especially frequency domain analysis, and practical implementation of DSP systems in software using Python and on microprocessors, to be able to design, select, use and apply actual and future DSP systems for various signal processing application in commercial products.

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**Module Contents****Lecture / Exercises**

Signals, Systems and Digital Signal Processing

Basic Elements of DSP Systems

Classification of Signals

Continuous-Time and Discrete-Time Signals

Deterministic and Random Signals

Even and Odd Signals

Periodic and Aperiodic Signals

Energy and Power of Signals

Some Fundamental Signals

Discrete-Time Linear Time-Invariant Systems

Difference Equations

Discrete-Time Convolution

Unit-Pulse and Impulse Response

Basic Systems Properties: Causality, Stability, Memory

Ideal Sampling and Reconstruction

Ideal Sampling and the Sampling Theorem

Aliasing

Fourier-Transform of Discrete-Time Signals

Eigenfunctions of Discrete-Time LTI Systems

Frequency response of Discrete-Time LTI Systems

The Fourier-Transform of Discrete-Time Signals

Ideal Continuous-Time Filters

Discrete Fourier-Transform

Sampling the DTFT

The DFT and the Inverse DFT

The Fast Fourier Transform

Radix-2 FFT Algorithms

Linear Convolution Using the FFT

Overlap-And-Add

Random Signals

Review of Probability and Random Variables

Ensemble Averages

Correlation Functions

Stationary and Ergodic Processes

Power Spectral Density

Transmission of Random Signals over LTI Systems

Advanced Sampling Techniques

Quantization and Encoding

Sampling of Bandpass Signals

Sampling of Random Signals

Sample Rate Conversion

Sample Rate Reduction by an Integer Factor

Sample Rate Increase by an Integer Factor

Sample Rate Conversion by a Rational Factor

Oversampling and Noise Shaping

Students understand the fundamentals of discrete-time signals and systems

Students can analyse the frequency content of a given signal using the appropriate Fourier-Transform and methods for spectrum estimation

Analysis of discrete-time LTI Systems

Students can calculate the output signal via convolution

Students can determine the frequency response of a given system

Students can characterize a given system in the frequency domain and in the z-domain

Implementation of discrete-time LTI systems  
 Students can implement the convolution sum in software  
 Students can implement different structures for IIR systems in software  
 Students can use the FFT to implement an FIR system

### Lab

Review of Probability and Random Variables  
 Moments, Averages and Distribution Functions  
 Random Signals  
 Ensemble Averages  
 Correlation Functions  
 Stationary and Ergodic Processes  
 Power Spectral Density  
 Transmission of Random Signals over LTI Systems  
 Combatting noise  
 Remove or suppress high-frequency noise from low-pass signals  
 Ability to trade-off different methods for digital coding of speech and audio signals

**Teaching and Learning Methods**

- Lecture / Exercises
- Lab

**Examination Types with Weights**

cf. exam regulations

**Workload** 150 Hours

**Contact Hours** 45 Hours  $\pm$  4 SWS

**Self-Study** 105 Hours

**Recommended Prerequisites**

No formal requirements, but students will be expected to be familiar with:  
 Basic Knowledge of Signals and Systems: Continuous-Time LTI-Systems and Convolution, Fourier-Transform  
 Basic Knowledge of Probability and Random Variables

**Mandatory Prerequisites**

- Lab requires attendance in the amount of: 8 Termine
- Participation in final examination only after successful participation in Lab

**Recommended Literature**

- John G. Proakis and Dimitris K. Manolakis. Digital Signal Processing (4th Edition). Prentice Hall, 2006.
- Alan V. Oppenheim, Ronald W. Schaffer. Discrete-Time Signal Processing (3rd Edition). Prentice Hall, 2007.
- Vinay Ingle and John Proakis. Digital Signal Processing using MATLAB. Cengage Learning Engineering, 2011.

**Use of the Module in Other Study Programs**

- DSP in Master Communication Systems and Networks 2020
- DSP in Master Communication Systems and Networks 2024
- DSP in Master Informatik und Systems-Engineering 2024

### Specifics and Notes

**Last Update** 19.7.2025, 14:32:16

## 6.10 ETH - Ethik

|                             |                                                                                          |
|-----------------------------|------------------------------------------------------------------------------------------|
| <b>Module ID</b>            | ETH_MaTIN2020                                                                            |
| <b>Module Name</b>          | Ethik                                                                                    |
| <b>Type of Module</b>       | Elective Modules                                                                         |
| <b>Recognized Course</b>    | ETH - Ethics                                                                             |
| <b>ECTS credits</b>         | 5                                                                                        |
| <b>Language</b>             | deutsch, englisch bei Bedarf                                                             |
| <b>Duration of Module</b>   | 1 Semester                                                                               |
| <b>Recommended Semester</b> | 1-2                                                                                      |
| <b>Frequency of Course</b>  | every term                                                                               |
| <b>Module Coordinator</b>   | Studiengangsleiter(in) Master Technische Informatik / Informatik und Systems-Engineering |
| <b>Lecturer(s)</b>          | NN/Lehrbeauftragter                                                                      |

### Learning Outcome(s)

Die Studierenden sind in der Lage, ein digitales Produkt gemäß aktueller Anforderungen an Sicherheit und Privatheit zu gestalten. Sie können indem sie

- die technischen, rechtlichen und ethischen Grundlagen von Datenschutz, Datensicherheit und Privacy verstehen,
  - Basistechnologien zu Authentifizierung und Autorisierung kennen und anwenden können,
  - Zielkonflikte zwischen funktionalen Anforderungen und ELSI (ethical / legal / social implications) erkennen und mit Hilfe von Analysemethoden bewerten, sowie
- daraus Schlussfolgerungen für die Hard- und Softwarearchitektur ziehen, indem etwa Sicherheits- / Privatsphärenaspekte in das Produkt integriert werden,
- so dass sie marktfähige und ethisch-rechtliche einwandfreie digitale Produkte erstellen können.

An ausgewählten Problemen zur Fragestellung "Ethische Fragestellungen im Coding", die in der wissenschaftlichen Literatur beschrieben sind, führen die Studierenden Untersuchungen durch, z.B. durch eigene weitere Literaturrecherche, Interviews mit Akteuren im C&C-Umfeld usw. Sie erarbeiten sich damit die Fähigkeit, ethische Problemstellungen in ihrer beruflichen Praxis zu erkennen und sie diskutieren zu können. Dazu betreiben sie

- Literaturrecherche,
- Diskussion digitaler Produkte unter ethischen Aspekten,
- Interviews mit Akteuren im technisch-informatischen-Umfeld usw.

Sie erarbeiten sich damit die Fähigkeit, eine auf ethischen Prinzipien beruhende Folgenabschätzung in ihrer beruflichen Praxis vorzunehmen und damit als "Global Citizen" verantwortungsvoll handeln zu können.

### Module Contents

#### Lecture / Exercises

- technical, regulatory and ethical foundations of data protection, security and privacy
- analytical methods for solving conflicting interests between system requirements and ELSi (ethical / legal / social implications)
- ethics' basic concepts

#### Seminar

- application of ethics on concrete scenarios

|                                      |                                                                                            |
|--------------------------------------|--------------------------------------------------------------------------------------------|
| <b>Teaching and Learning Methods</b> | <ul style="list-style-type: none"> <li>▪ Lecture / Exercises</li> <li>▪ Seminar</li> </ul> |
|--------------------------------------|--------------------------------------------------------------------------------------------|

|                                       |                      |
|---------------------------------------|----------------------|
| <b>Examination Types with Weights</b> | cf. exam regulations |
|---------------------------------------|----------------------|

|                 |           |
|-----------------|-----------|
| <b>Workload</b> | 150 Hours |
|-----------------|-----------|

|                                                  |                                                       |
|--------------------------------------------------|-------------------------------------------------------|
| <b>Contact Hours</b>                             | 45 Hours $\triangleq$ 4 SWS                           |
| <b>Self-Study</b>                                | 105 Hours                                             |
| <b>Recommended Prerequisites</b>                 | none                                                  |
| <b>Mandatory Prerequisites</b>                   |                                                       |
| <b>Recommended Literature</b>                    |                                                       |
| <b>Use of the Module in Other Study Programs</b> | ETH in Master Informatik und Systems-Engineering 2024 |
| <b>Specifics and Notes</b>                       |                                                       |
| <b>Last Update</b>                               | 19.7.2025, 14:32:16                                   |

## 6.11 FP - Forschungsprojekt

|                             |                                                                                          |
|-----------------------------|------------------------------------------------------------------------------------------|
| <b>Module ID</b>            | FP_MaTIN2020                                                                             |
| <b>Module Name</b>          | Forschungsprojekt                                                                        |
| <b>Type of Module</b>       | Mandatory Module                                                                         |
| <b>Recognized Course</b>    | FP - Forschungsprojekt                                                                   |
| <b>ECTS credits</b>         | 10                                                                                       |
| <b>Language</b>             | deutsch und englisch                                                                     |
| <b>Duration of Module</b>   | 1 Semester                                                                               |
| <b>Recommended Semester</b> | 2                                                                                        |
| <b>Frequency of Course</b>  | every term                                                                               |
| <b>Module Coordinator</b>   | Studiengangsleiter(in) Master Technische Informatik / Informatik und Systems-Engineering |
| <b>Lecturer(s)</b>          | verschiedene Dozenten*innen / diverse lecturers                                          |

### Learning Outcome(s)

Studierende untersuchen und lösen eine wissenschaftliche Problemstellung, indem sie

- selbständig den aktuellen Stand der Wissenschaft auf einem Fachgebiet durch Literaturrecherche erarbeiten,
- ein eigenes Projekt in Abstimmung mit Kollegen planen, durchführen und kontrollieren,
- das gegebene Problem selbständig (oder im Team) mit wissenschaftlichen Methoden untersuchen und lösen,
- im Studium erworbenes Fachwissen auf Problemstellung anwenden und hierbei vertiefen,
- eigene Lösung mit alternativen Lösungsmöglichkeiten vergleichen,
- erstellte Lösung in Gesamtzusammenhang einordnen und aus fachlicher und gesellschaftlicher Sicht kritisch bewerten und
- den Stand der Wissenschaft, die fachlichen Grundlagen, die gewählte Lösung und ihre Bewertung gegenüber den weiteren möglichen Lösungsalternativen klar und nachvollziehbar in schriftlicher auf Englisch Form darstellen sowie
- mündlich auf Englisch präsentieren und verteidigen.

um wissenschaftliche Methoden in folgenden Modulen, insbesondere der Masterarbeit, und späteren Berufsleben anwenden zu können.

### Module Contents

#### *Research Project*

|                                                  |                                                      |
|--------------------------------------------------|------------------------------------------------------|
| <b>Teaching and Learning Methods</b>             | Research Project                                     |
| <b>Examination Types with Weights</b>            | cf. exam regulations                                 |
| <b>Workload</b>                                  | 300 Hours                                            |
| <b>Contact Hours</b>                             | 12 Hours $\pm$ 1 SWS                                 |
| <b>Self-Study</b>                                | 288 Hours                                            |
| <b>Recommended Prerequisites</b>                 |                                                      |
| <b>Mandatory Prerequisites</b>                   |                                                      |
| <b>Recommended Literature</b>                    |                                                      |
| <b>Use of the Module in Other Study Programs</b> | FP in Master Informatik und Systems-Engineering 2024 |
| <b>Specifics and Notes</b>                       |                                                      |

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**Last Update**

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## 6.12 HIM - Advanced Mathematics

|                      |                                                                                                                                                                                                                    |
|----------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Module ID            | HIM_MaTIN2020                                                                                                                                                                                                      |
| Module Name          | Advanced Mathematics                                                                                                                                                                                               |
| Type of Module       | Elective Modules                                                                                                                                                                                                   |
| Recognized Course    | HIM - Advanced Mathematics                                                                                                                                                                                         |
| ECTS credits         | 5                                                                                                                                                                                                                  |
| Language             | deutsch und englisch                                                                                                                                                                                               |
| Duration of Module   | 1 Semester                                                                                                                                                                                                         |
| Recommended Semester | 1-2                                                                                                                                                                                                                |
| Frequency of Course  | every term                                                                                                                                                                                                         |
| Module Coordinator   | Prof. Dr. Heiko Knospe/Professor Fakultät IME                                                                                                                                                                      |
| Lecturer(s)          | <ul style="list-style-type: none"><li>▪ Prof. Dr. Heiko Knospe/Professor Fakultät IME</li><li>▪ Prof. Dr. Hubert Randerath/Professor Fakultät IME</li><li>▪ Prof. Dr. Beate Rhein/Professor Fakultät IME</li></ul> |

### Learning Outcome(s)

Was: Das Modul vermittelt grundlegende Konzepte und Methoden der Mathematik, die in den Ingenieurwissenschaften benötigt werden (K. 8). Die Abstraktion und mathematischen Formalisierung von Problemen soll erlernt und angewendet werden (K. 2). Die Studierenden lernen die Anwendung mathematischer Methoden (K. 16). Es soll die Anwendung statistischer Verfahren und die Begründung wissenschaftlicher Aussagen erlernt werden (K. 17).

Womit: Der Dozent/die Dozentin vermittelt Wissen und Basisfertigkeiten in der Vorlesung. In der Übung bearbeiten die Studierenden unter Anleitung Aufgaben. Die Übung wird durch Hausaufgaben und Online-Aufgaben (E-Learning) ergänzt.

Wozu: Fortgeschrittene Mathematik-Kenntnisse (beispielweise in Vektoranalysis, Statistik und Optimierung) werden in mehreren Modulen des Studiengangs benötigt. Mathematische Methoden sind essentiell für Ingenieure, die wissenschaftlich arbeiten und wissenschaftliche Erkenntnisse anwenden und erweitern (HF2).

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**Module Contents****Lecture / Exercises**

A combination of:

- Vector Analysis
- Probability Theory, Statistics and Multivariate Statistics
- Stochastic processes
- Optimization

Vector Analysis

- Vector Spaces
- Scalar and Vector Functions
- Differential Operators
- Line Integrals
- Double Integrals
- Triple Integrals
- Change of Variables
- Surface Integrals
- Divergence Theorem
- Theorem of Stokes
- Maxwell Equations

Probability and Statistics

- Descriptive Statistics
- Two-dimensional Data
- Simple Linear Regression
- Probability Spaces
- Random Variables
- Expectation, Variance, Moments
- Jointly Distributed Random Variables
- Independent Random Variables
- Covariance
- Binomial Random Variable
- Poisson Random Variable
- Uniform Random Variable
- Normal Random Variable
- Chi-Square Distribution
- t-Distribution
- Central Limit Theorem
- Distributions of Sampling Statistics
- Confidence Intervals
- Hypothesis Testing
- t-Test, f-Test, Chi-Square Test
- Overview of various Tests

Multivariate Statistics

- Analysis of multidimensional data
- Multivariate Random Variables
- Matrix decompositions, Singular Value Decomposition (SVD)
- Factor analysis, Principal Component Analysis (PCA)
- Multiple Linear Regression

Stochastic Processes

- Discrete and continuous time processes
- Random walk
- Markov chain
- Poisson process
- Queuing theory

## Optimization

- Linear Programming
- Unconstrained Optimization: Gradient method, Newton's method, Trust Region method
- Constrained Optimization: Karush–Kuhn–Tucker (KKT) conditions, Lagrange multipliers, Penalty and Barrier functions
- Special optimization problems: Mixed Integer Nonlinear Programming, Nonlinear Stochastic Optimization

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**Teaching and Learning Methods**

Lecture / Exercises

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**Examination Types with Weights**

cf. exam regulations

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**Workload** 150 Hours

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**Contact Hours** 34 Hours  $\triangleq$  3 SWS

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**Self-Study** 116 Hours

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**Recommended Prerequisites** Differential and integral calculus and linear algebra (Bachelor-level mathematics)

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**Mandatory Prerequisites**

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**Recommended Literature**

- K. Burg, H. Haf, F. Wille, A. Meister, Vektoranalysis - Höhere Mathematik für Ingenieure, Naturwissenschaftler und Mathematiker, Springer Vieweg
- E. Kreyszig, Advanced Engineering Mathematics, John Wiley & Sons
- L. Papula, Mathematik für Ingenieure und Naturwissenschaftler Band 3, Springer Vieweg
- R. E. Walpole, R. H. Myers, S. L. Myers, K. Ye, Probability & Statistics for Engineers & Scientists, Prentice Hall
- S. M. Ross, Probability and Statistics for Engineers and Scientists, Elsevier
- S. M. Ross, Stochastic Processes, John Wiley & Sons
- U. Krengel, Einführung in die Wahrscheinlichkeitstheorie und Statistik
- A. Koop, H. Moock, Lineare Optimierung, Springer
- R. Reinhardt, A. Hoffmann, T. Gerlach, Nichtlineare Optimierung, Springer
- M. Ulbrich, S. Ulbrich, Nichtlineare Optimierung, Birkhäuser

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**Use of the Module in Other Study Programs**

- HIM in Master Communication Systems and Networks 2020
- HIM in Master Communication Systems and Networks 2024
- HIM in Master Elektrotechnik 2020
- HIM in Master Elektrotechnik und Informationstechnik 2024
- HIM in Master Informatik und Systems-Engineering 2024

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**Specifics and Notes**

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**Last Update** 19.7.2025, 14:32:16

### 6.13 IBD - InnoBioDiv

|                             |                                              |
|-----------------------------|----------------------------------------------|
| <b>Module ID</b>            | IBD_MaTIN2020                                |
| <b>Module Name</b>          | InnoBioDiv                                   |
| <b>Type of Module</b>       | Elective Modules                             |
| <b>Recognized Course</b>    | IBD - InnoBioDiv student projects            |
| <b>ECTS credits</b>         | 5                                            |
| <b>Language</b>             | englisch                                     |
| <b>Duration of Module</b>   | 0.5 Semester                                 |
| <b>Recommended Semester</b> | 1-2                                          |
| <b>Frequency of Course</b>  | every term                                   |
| <b>Module Coordinator</b>   | Prof. Dr. Uwe Dettmar/Professor Fakultät IME |
| <b>Lecturer(s)</b>          | Prof. Dr. Uwe Dettmar/Professor Fakultät IME |

#### Learning Outcome(s)

Die Studierenden können in einer Forschungsgruppe ein Experiment teamorientiert planen, durchführen, auswerten und dokumentieren, indem sie auf biologisches und technisches Basiswissen und auf die zur Verfügung gestellten Ressourcen (ein IoT basiertes Mess- und Steuersystem inklusive FarmBot, Sensorik und Aktorik, Materialien und Geräte im Gewächshaus des Instituts für Pflanzenwissenschaften, Checklisten) sowie weitere frei verfügbare Informationsquellen zugreifen, um die Auswirkungen des Klimawandels auf die Wachstumsleistung von Pflanzen und die Biodiversität im Boden erfahrbar zu machen und dadurch Erkenntnisse zu generieren, die für die Gesellschaft im Rahmen des Klimawandels von Relevanz sind.

#### Module Contents

##### *Seminar*

Development of project ideas, discussion and further development of the projects

##### *Project*

The students acquire...

- the ability to develop and implement concepts for the adaptation of plants to climate change.
- the ability to plan, conduct and analyze experiments in the fields of plant physiology, soil biology and technology.
- the ability to statistically evaluate and present experimental data.
- the ability to present and communicate scientific results.
- the ability to collaborate interdisciplinary and interculturally and to exchange ideas with students from different MINT research areas.
- Experience in planning and implementing projects and in teamwork

At the end, students will have

- a deep understanding of the interactions between climate parameters, plant growth and soil biodiversity.
- basic knowledge of modern technologies such as robotics, sensor technology and the Internet of Things in the context of plant research.
- an awareness of the importance of sustainability, resource conservation and security of supply in the context of population growth and climate change.

|                                      |                                                                                |
|--------------------------------------|--------------------------------------------------------------------------------|
| <b>Teaching and Learning Methods</b> | <ul style="list-style-type: none"> <li>▪ Seminar</li> <li>▪ Project</li> </ul> |
|--------------------------------------|--------------------------------------------------------------------------------|

|                                       |                      |
|---------------------------------------|----------------------|
| <b>Examination Types with Weights</b> | cf. exam regulations |
|---------------------------------------|----------------------|

|                 |           |
|-----------------|-----------|
| <b>Workload</b> | 150 Hours |
|-----------------|-----------|

|                      |                      |
|----------------------|----------------------|
| <b>Contact Hours</b> | 23 Hours $\pm$ 2 SWS |
|----------------------|----------------------|

|                   |           |
|-------------------|-----------|
| <b>Self-Study</b> | 127 Hours |
|-------------------|-----------|

|                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Recommended Prerequisites</b>                 | <ul style="list-style-type: none"><li>- fluent English since working intercultural and interdisciplinary teams.</li><li>- basic knowledge in IoT and robotics desirable</li><li>- ability to work in a team</li><li>- basic knowledge in plant biology are not mandatory</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Mandatory Prerequisites</b>                   | <ul style="list-style-type: none"><li>▪ Seminar requires attendance in the amount of: 8 Stunden</li><li>▪ Project requires attendance in the amount of: 5 meetings for project discussions</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Recommended Literature</b>                    | <ul style="list-style-type: none"><li>▪ <a href="https://farm.bot/">https://farm.bot/</a></li><li>▪ Arif, Tarik M.: Deep Learning on Embedded Systems: A Hands-On Approach Using Jetson Nano and Raspberry Pi, Wiley, 2025, ISBN:978-1-394-26927-3</li><li>▪ Agrawal, D. P. (2017). Embedded Sensor Systems. Springer.</li><li>▪ Marwedel, Peter: Embedded System Design: Embedded Systems Foundations of Cyber-Physical Systems, and the Internet of Things, Springer, 2021, ISBN 978-3-030-60910-8</li><li>▪ L. Urry, S. Wassermann: Campbell Biology AP Edition (12th Edition), Pearson, ISBN-13: 978-0-13-648687-9</li><li>▪ Taiz, L., Møller, I. M., Murphy, A., &amp; Zeiger, E. (2022). Plant Physiology and Development. Oxford University Press.</li></ul> |
| <b>Use of the Module in Other Study Programs</b> | <ul style="list-style-type: none"><li>▪ IBD in Master Communication Systems and Networks 2020</li><li>▪ IBD in Master Communication Systems and Networks 2024</li><li>▪ IBD in Master Elektrotechnik und Informationstechnik 2024</li><li>▪ IBD in Master Medientechnologie 2024</li><li>▪ IBD in Master Informatik und Systems-Engineering 2024</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Permanent Links to Organization</b>           | <a href="#"><u>Course description in the learning platform</u></a>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Specifics and Notes</b>                       | Block course from the beginning of October to mid-November (7 weeks), optional preparation time to build up basic knowledge in the last week of September                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Last Update</b>                               | 19.7.2025, 14:32:16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

## 6.14 IIS - Intelligent Information Systems

|                             |                                                  |
|-----------------------------|--------------------------------------------------|
| <b>Module ID</b>            | IIS_MaTIN2020                                    |
| <b>Module Name</b>          | Intelligent Information Systems                  |
| <b>Type of Module</b>       | Elective Modules                                 |
| <b>Recognized Course</b>    | IIS - Intelligent Information Systems            |
| <b>ECTS credits</b>         | 5                                                |
| <b>Language</b>             | deutsch, englisch bei Bedarf                     |
| <b>Duration of Module</b>   | 1 Semester                                       |
| <b>Recommended Semester</b> | 1-2                                              |
| <b>Frequency of Course</b>  | every summer term                                |
| <b>Module Coordinator</b>   | Prof. Dr. Andreas Behrend/Professor Fakultät IME |
| <b>Lecturer(s)</b>          | Prof. Dr. Andreas Behrend/Professor Fakultät IME |

### Learning Outcome(s)

Die Studierenden kennen die verschiedenen Möglichkeiten zur Darstellung von Wissen und können die Vor – und Nachteile einer Darstellungsform bewerten.

Die Studierenden erarbeiten sich grundlegende Kenntnisse zur Theorie und Anwendung von deklarativen Programmiersprachen bzw. Regelsystemen.

Die Studierenden kennen gängige Typen von Optimierungs- bzw. Suchproblemen und können geeignete deklarative Lösungsansätze identifizieren.

Die Studierenden kennen die wichtigsten Inferenzmethoden und können diese einordnen bzw. bewerten.

Die Studierenden kennen die Resolutionsmethode und das Verfahren der Unifikation und können diese für eine Problemstellung anwenden.

Die Studierenden kennen die wichtigsten Formen der Operationalisierung deklarativer Ausdrücke und können diese bzgl. ihrer Effizienz bei einem Lösungsansatz bewerten.

Die Studierenden können für reale Problemstellungen eine geeignete Wissensrepräsentation wählen und eine Lösung mit einem deklarativen Programm erarbeiten.

Die Studierenden können aktuelle deklarative Anfragesprachen klassifizieren und hinsichtlich ihrer Ausdrucksmächtigkeit bewerten.

Die Studierenden können mit gängigen deklarativen Programmiersprachen umgehen.

Die Studierenden können Aufgaben in einem kleinen Team lösen.

Die Studierenden können Programmcode verstehen und um Funktionalität erweitern. Sie können das Verhalten einer programmierten Lösung bewerten und durch geeignete Modifikationen verbessern.

Die Studierenden können internationale wissenschaftliche Literatur analysieren, einordnen, in ihren Kontext stellen und präsentieren.

**Module Contents****Lecture / Exercises**

## Foundations of Knowledge Representation

- First-order logic
- relational, functional, tree-based, graph-oriented fact representation (semantic networks, ontologies)
- rule-based systems

## Automatic reasoning and inference methods

- resolution principle (incl. unification)
- forward and backward chaining
- fixpoint semantics

## Declarative Programming languages

- Functional programming
- relational (logical) programming , e.g., Prolog, Datalog, SQL and SPARQL

Outlook on current research issues, e.g., query languages, parallel algorithms, distributed systems, combinatorial optimization and language processing.

Students have acquired basic knowledge about methods for representing knowledge, automatic reasoning as well as declarative programming languages. They understand the various ways of operationalizing declarative expressions and are able to realize suitable programming solutions for given problems.

**Lab**

Representing knowledge by sets of tuples, relations, semantic networks as well as logic-based systems

Implementing calculation problems with a functional programming language (e.g. Haskell) using expressions, algebraic data types, infinite data structures and higher-order functions

Solving search problems with a logical programming language and recursive expressions

Formulating relational queries over knowledge bases (e.g. using SPQAQL or Datalog)

**Teaching and Learning**     ■ Lecture / Exercises

**Methods**                     ■ Lab

**Examination Types with Weights**     cf. exam regulations

**Workload**                     150 Hours

**Contact Hours**             45 Hours  $\triangleq$  4 SWS

**Self-Study**                    105 Hours

**Recommended Prerequisites**           programming skills, knowledge about data structures and algorithms

**Mandatory Prerequisites**

- Recommended Literature**
- G. Hutton: Programming in Haskell, 2nd Ed., Cambridge University Press, 2016
  - L. Sterling, E. Shapiro: The Art of Prolog, 2nd Ed., MIT Press, 1994
  - Uwe Schöning. Logik für Informatiker. 5. Auflage, Spektrum Akademischer Verlag, 2000
  - Pascal Hitzler, Markus Krötzsch, Sebastian Rudolph. Foundations of Semantic Web Technologies. CRC Press 2009.
  - S.J. Russell, P. Norvig: Artificial Intelligence. A Modern Approach, 2. Aufl. Prentice Hall, 2003

**Use of the Module in Other Study Programs**     IIS in Master Informatik und Systems-Engineering 2024

**Specifics and Notes**

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**Last Update**

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## 6.15 ITF - IT-Forensik

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|-----------------------------|------------------------------------------------------------------------------------------|
| <b>Module ID</b>            | ITF_MaTIN2020                                                                            |
| <b>Module Name</b>          | IT-Forensik                                                                              |
| <b>Type of Module</b>       | Elective Modules                                                                         |
| <b>Recognized Course</b>    | ITF - IT forensics                                                                       |
| <b>ECTS credits</b>         | 5                                                                                        |
| <b>Language</b>             | deutsch, englisch bei Bedarf                                                             |
| <b>Duration of Module</b>   | 1 Semester                                                                               |
| <b>Recommended Semester</b> | 1-2                                                                                      |
| <b>Frequency of Course</b>  | every winter term                                                                        |
| <b>Module Coordinator</b>   | Studiengangsleiter(in) Master Technische Informatik / Informatik und Systems-Engineering |
| <b>Lecturer(s)</b>          | Jürgen Bornemann/Lehrbeauftragter                                                        |

### Learning Outcome(s)

- **WAS** Studierende spüren digitale Beweise auf und stellen Sie zwecks Verwertbarkeit für weiterführende Analysen sicher,
- **WOMIT** indem sie anhand fallbezogener Aufgabenstellungen und mittels forensischer IT-Tools Schwachstellen entdecken und Beweise in Dateisystemen und IT-Infrastrukturen sichern,
- **WOZU** um im Berufsleben Gefahren vermeiden, erkennen und abwehren können und ggf. gutachterlich tätig zu werden.

### Module Contents

#### Lecture / Exercises

Basic concepts of cyber security and digital forensics  
 Typical vulnerabilities, threats and risks  
 Dangers with mobile systems, home office, WLANs  
 Basics and working methods of IT forensics  
 Forensic documentation creation  
 Common tools for forensic investigations  
 Recognize and secure digital evidence  
 Open source forensics  
 File system forensics  
 Forensic analysis of mobile systems  
 Vulnerabilities, threats, attacks on network structures  
 KALI Linux - Operating System for Vulnerability and Pentesting

#### Project

Students can work on case-related forensic tasks and incidents independently or in working groups using the knowledge they have acquired. They show how to secure, analyze and document digital evidence.

|                                      |                                                                                            |
|--------------------------------------|--------------------------------------------------------------------------------------------|
| <b>Teaching and Learning Methods</b> | <ul style="list-style-type: none"> <li>▪ Lecture / Exercises</li> <li>▪ Project</li> </ul> |
|--------------------------------------|--------------------------------------------------------------------------------------------|

|                                       |                      |
|---------------------------------------|----------------------|
| <b>Examination Types with Weights</b> | cf. exam regulations |
|---------------------------------------|----------------------|

|                      |                      |
|----------------------|----------------------|
| <b>Workload</b>      | 150 Hours            |
| <b>Contact Hours</b> | 45 Hours $\pm$ 4 SWS |
| <b>Self-Study</b>    | 105 Hours            |

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**Recommended  
Prerequisites**

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**Mandatory  
Prerequisites**

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**Recommended  
Literature**

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|                                                      |                                                             |
|------------------------------------------------------|-------------------------------------------------------------|
| <b>Use of the Module in<br/>Other Study Programs</b> | ▪ ITF in Master Communication Systems and Networks 2020     |
|                                                      | ▪ ITF in Master Communication Systems and Networks 2024     |
|                                                      | ▪ ITF in Master Elektrotechnik 2020                         |
|                                                      | ▪ ITF in Master Elektrotechnik und Informationstechnik 2024 |
|                                                      | ▪ ITF in Master Medientechnologie 2020                      |
|                                                      | ▪ ITF in Master Medientechnologie 2024                      |
|                                                      | ▪ ITF in Master Informatik und Systems-Engineering 2024     |

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**Specifics and Notes**

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| <b>Last Update</b> | 19.7.2025, 14:32:16 |
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## 6.16 KOGA - Kombinatorische Optimierung und Graphenalgorithmen

|                             |                                                        |
|-----------------------------|--------------------------------------------------------|
| <b>Module ID</b>            | KOGA_MaTIN2020                                         |
| <b>Module Name</b>          | Kombinatorische Optimierung und Graphenalgorithmen     |
| <b>Type of Module</b>       | Elective Modules                                       |
| <b>Recognized Course</b>    | KOGA - Combinatorial Optimization and Graph Algorithms |
| <b>ECTS credits</b>         | 5                                                      |
| <b>Language</b>             | deutsch                                                |
| <b>Duration of Module</b>   | 1 Semester                                             |
| <b>Recommended Semester</b> | 1-2                                                    |
| <b>Frequency of Course</b>  | every winter term                                      |
| <b>Module Coordinator</b>   | Prof. Dr. Hubert Randerath/Professor Fakultät IME      |
| <b>Lecturer(s)</b>          | Prof. Dr. Hubert Randerath/Professor Fakultät IME      |

### Learning Outcome(s)

Die Studierenden sind in der Lage Verfahren und Konzepte der Graphentheorie und der Kombinatorischen Optimierung zur Beschreibung und algorithmischen Lösung von Problemstellungen der Informatik, der Technik und des täglichen Lebens anzuwenden.

Sie haben die Fertigkeit Verfahren und Konzepte der Graphentheorie und der Kombinatorischen Optimierung zur Beschreibung und algorithmischen Lösung von Problemstellungen der Informatik, der Technik und des täglichen Lebens anzupassen.

Sie können algorithmische Denk- und Arbeitsweisen wie Komplexität von Problemklassen, Effizienz von Algorithmen und Approximation, die sie induktiv an Optimierungsaufgaben in Netzwerken und gewichteten Graphen erlernt haben, anwenden.

### Module Contents

#### Lecture / Exercises

- Basics of Graph Theory und Combinatorial Optimization
- Minimal Spanning Trees: algorithms of Kruskal, Prim und Tarjan, Greedy algorithms, matroids, Steiner trees, network design
- Linear Programs: structure, modelling, normalization, Simplex algorithm, Theory of Duality
- Weighted Matchings and the Route Inspection Problem: Weighted Matchings in Bipartite Graphs and non-bipartite Graphs, algorithms of Floyd-Warshall and Fleury
- Network Flows: Network Theory Basics, Dinic's algorithms, cost-optimal flows
- selected discrete and combinatorial optimization problems: Travelling Salesman, Channel Assignment Problem, scheduling problems, routing problems

#### Exercises / Lab

|                                      |                                                                                                    |
|--------------------------------------|----------------------------------------------------------------------------------------------------|
| <b>Teaching and Learning Methods</b> | <ul style="list-style-type: none"> <li>▪ Lecture / Exercises</li> <li>▪ Exercises / Lab</li> </ul> |
|--------------------------------------|----------------------------------------------------------------------------------------------------|

|                                       |                      |
|---------------------------------------|----------------------|
| <b>Examination Types with Weights</b> | cf. exam regulations |
|---------------------------------------|----------------------|

|                 |           |
|-----------------|-----------|
| <b>Workload</b> | 150 Hours |
|-----------------|-----------|

|                      |                      |
|----------------------|----------------------|
| <b>Contact Hours</b> | 57 Hours $\pm$ 5 SWS |
|----------------------|----------------------|

|                   |          |
|-------------------|----------|
| <b>Self-Study</b> | 93 Hours |
|-------------------|----------|

|                                  |                                                                    |
|----------------------------------|--------------------------------------------------------------------|
| <b>Recommended Prerequisites</b> | Basic knowledge in graph theory<br>Basic knowledge in algorithmics |
|----------------------------------|--------------------------------------------------------------------|

|                                |                                                                                                                                                                                                          |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Mandatory Prerequisites</b> | <ul style="list-style-type: none"> <li>▪ Lecture / Exercises requires attendance in the amount of: 1 Vortragstermin</li> <li>▪ Exercises / Lab requires attendance in the amount of: 1 Termin</li> </ul> |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

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**Recommended  
Literature**

- Mathematik zum Studienbeginn, Arnfried Kemnitz, Springer Spektrum Verlag
- Algorithmische Graphentheorie, Volker Turau und Christian Weyer, De Gruyter Verlag
- Graphentheoretische Konzepte und Algorithmen, Sven Krumke und Harald Noltemeier, Springer Vieweg Verlag
- Einführung in die angewandte Wirtschaftsmathematik, Jürgen Tietze, Springer Spektrum Verlag
- Graph Algorithms - Practical Examples in Apache Spark & Neo4j, Mark Needham and Amy Hodler, O'Reilly Verlag

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**Use of the Module in  
Other Study Programs**

KOGA in Master Informatik und Systems-Engineering 2024

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**Specifics and Notes**

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**Last Update**

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**6.17 KOLL - Kolloquium zur Masterarbeit**

|                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Module ID</b>                                 | KOLL_MaTIN2020                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Module Name</b>                               | Kolloquium zur Masterarbeit                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Type of Module</b>                            | Mandatory Module                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Recognized Course</b>                         | MAKOLL - Colloquium                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>ECTS credits</b>                              | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Language</b>                                  | deutsch, englisch bei Bedarf                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Duration of Module</b>                        | 1 Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Recommended Semester</b>                      | 3                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Frequency of Course</b>                       | every term                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Module Coordinator</b>                        | Studiengangsleiter(in) Master Technische Informatik / Informatik und Systems-Engineering                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Lecturer(s)</b>                               | verschiedene Dozenten*innen / diverse lecturers                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Learning Outcome(s)</b>                       | <ul style="list-style-type: none"> <li>- Darstellung von Forschungsergebnissen in einer Präsentation in vorgegebenem engen zeitlichen Rahmen</li> <li>- Fachliche und außerfachliche Bezüge der eigenen Arbeit darstellen und begründen</li> <li>- Eigene Lösungswege und gewonnene Erkenntnisse darstellen und diskutieren</li> </ul>                                                                                                                               |
| <b>Module Contents</b>                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Colloquium</b>                                | <p>The colloquium serves to determine whether the student is able to present the results of the Master's thesis, its technical and methodological foundations, interdisciplinary contexts and extracurricular references orally, to justify them independently and to assess their significance for practice</p>                                                                                                                                                     |
| <b>Teaching and Learning Methods</b>             | Colloquium                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Examination Types with Weights</b>            | cf. exam regulations                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Workload</b>                                  | 90 Hours                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Contact Hours</b>                             | 0 Hours $\triangleq$ 0 SWS                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Self-Study</b>                                | 90 Hours                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Recommended Prerequisites</b>                 |                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Mandatory Prerequisites</b>                   | <ul style="list-style-type: none"> <li>■ Module MAA: Die Masterarbeit muss abgeschlossen sein, damit sie im Kolloquium ganzheitlich und abschließend präsentiert werden kann.</li> <li>■ See exam regulations §29, paragraph 2</li> </ul>                                                                                                                                                                                                                            |
| <b>Recommended Literature</b>                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| <b>Use of the Module in Other Study Programs</b> | <ul style="list-style-type: none"> <li>■ KOLL in Master Communication Systems and Networks 2020</li> <li>■ KOLL in Master Communication Systems and Networks 2024</li> <li>■ KOLL in Master Elektrotechnik 2020</li> <li>■ KOLL in Master Elektrotechnik und Informationstechnik 2024</li> <li>■ KOLL in Master Medientechnologie 2020</li> <li>■ KOLL in Master Medientechnologie 2024</li> <li>■ KOLL in Master Informatik und Systems-Engineering 2024</li> </ul> |
| <b>Specifics and Notes</b>                       | See also examination regulations §29.                                                                                                                                                                                                                                                                                                                                                                                                                                |
| <b>Last Update</b>                               | 19.7.2025, 14:32:16                                                                                                                                                                                                                                                                                                                                                                                                                                                  |

## 6.18 KRY - Cryptography

|                             |                                               |
|-----------------------------|-----------------------------------------------|
| <b>Module ID</b>            | KRY_MaTIN2020                                 |
| <b>Module Name</b>          | Cryptography                                  |
| <b>Type of Module</b>       | Elective Modules                              |
| <b>Recognized Course</b>    | KRY - Cryptography                            |
| <b>ECTS credits</b>         | 5                                             |
| <b>Language</b>             | englisch                                      |
| <b>Duration of Module</b>   | 1 Semester                                    |
| <b>Recommended Semester</b> | 1-2                                           |
| <b>Frequency of Course</b>  | every summer term                             |
| <b>Module Coordinator</b>   | Prof. Dr. Heiko Knospe/Professor Fakultät IME |
| <b>Lecturer(s)</b>          | Prof. Dr. Heiko Knospe/Professor Fakultät IME |

### Learning Outcome(s)

Was: Die Studierenden lernen die mathematischen Grundlagen der Kryptographie kennen. Es werden Kenntnisse der wichtigsten kryptographischen Methoden und Algorithmen vermittelt (HF 1). Die Studierenden verstehen verschiedene Arten von Sicherheitsanforderungen und analysieren die Sicherheit von kryptographischen Verfahren.

Womit: Der Dozent/die Dozentin vermittelt Wissen und Basisfertigkeiten in der Vorlesung. In der Übung bearbeiten die Studierenden unter Anleitung Aufgaben. Im Praktikum werden konkrete Probleme und Fragestellungen der Kryptographie bearbeitet.

Wozu: Kryptographie wird eingesetzt um die grundlegenden Ziele der Informationssicherheit zu erreichen. Die Studierenden lernen die Implementierung und Anwendung von kryptographischen Algorithmen und entwickeln Konzepte um Systeme, Netzwerke und Anwendungen gegen Angriffe zu sichern (HF 2).

### Module Contents

#### Lecture / Exercises

- \* Mathematical Fundamentals
- \* Encryption Schemes and Definitions of Security
- \* Elementary Number Theory
- \* Algebraic Structures
- \* Block Ciphers
- \* Stream Ciphers
- \* Hash Functions
- \* Message Authentication Codes
- \* Public-Key Encryption and the RSA Cryptosystem
- \* Key Establishment
- \* Digital Signatures
- \* Elliptic Curve Cryptography
- \* Outlook: Post-quantum cryptography

#### Lab

- Solve mathematical and cryptographical problems in Python / SageMath: working with large integers and residue classes, factorization, primality and prime density, RSA key generation and encryption / decryption, Diffie-Hellman key exchange.
- Write code to encrypt and decrypt files using the AES block cipher and different operation modes. Analyze the statistical properties of AES ciphertext.
- Write code for RSA key generation, key encapsulation / decapsulation and hybrid encryption / decryption.

- Teaching and Learning Methods**
- Lecture / Exercises
  - Lab

**Examination Types with Weights** cf. exam regulations

|                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Workload</b>                                  | 150 Hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Contact Hours</b>                             | 45 Hours $\triangleq$ 4 SWS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Self-Study</b>                                | 105 Hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Recommended Prerequisites</b>                 | Mathematics (Bachelor level) and programming skills.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Mandatory Prerequisites</b>                   | <ul style="list-style-type: none"><li>▪ Lab requires attendance in the amount of: 3 Termine</li><li>▪ Participation in final examination only after successful participation in Lab</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Recommended Literature</b>                    | <ul style="list-style-type: none"><li>▪ M. Bellare, P. Rogaway, Introduction to Modern Cryptography, UCSD CSE</li><li>▪ H. Delfs, H. Knebl, Introduction to Cryptography, Springer</li><li>▪ S. Goldwasser, M. Bellare, Lecture Notes on Cryptography, MIT</li><li>▪ J. Hoffstein, J. Pipher, J.H. Silverman, An Introduction to Mathematical Cryptography, Springer</li><li>▪ J. Katz, Y. Lindell, Introduction to Modern Cryptography, CRC Press</li><li>▪ H. Knospe, A Course in Cryptography, American Mathematical Society</li><li>▪ C. Paar, J. Pelz, Understanding Cryptography. Springer</li><li>▪ N.P. Smart, Cryptography Made Simple, Springer</li><li>▪ K. H. Rosen, Discrete Mathematics and its Applications, McGraw-Hill</li><li>▪ V. Shoup, A Computational Introduction to Number Theory and Algebra, Cambridge University Press</li></ul> |
| <b>Use of the Module in Other Study Programs</b> | <ul style="list-style-type: none"><li>▪ KRY in Master Communication Systems and Networks 2020</li><li>▪ KRY in Master Communication Systems and Networks 2024</li><li>▪ KRY in Master Informatik und Systems-Engineering 2024</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Specifics and Notes</b>                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| <b>Last Update</b>                               | 19.7.2025, 14:32:16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |

**6.19 LCSS - Large and Cloud-based Software-Systems**

|                             |                                                  |
|-----------------------------|--------------------------------------------------|
| <b>Module ID</b>            | LCSS_MaTIN2020                                   |
| <b>Module Name</b>          | Large and Cloud-based Software-Systems           |
| <b>Type of Module</b>       | Elective Modules                                 |
| <b>Recognized Course</b>    | LCSS - Large and Cloud-based Software-Systems    |
| <b>ECTS credits</b>         | 5                                                |
| <b>Language</b>             | englisch                                         |
| <b>Duration of Module</b>   | 1 Semester                                       |
| <b>Recommended Semester</b> | 1-2                                              |
| <b>Frequency of Course</b>  | every summer term                                |
| <b>Module Coordinator</b>   | Prof. Dr. René Würzberger/Professor Fakultät IME |
| <b>Lecturer(s)</b>          | Prof. Dr. René Würzberger/Professor Fakultät IME |

**Learning Outcome(s)**

Students are capable of

- designing architectures for complex and mission critical enterprise software systems,
- implementing these systems and
- operate them in the Cloud

by

- knowing and trading conflicting interests and concerns of stakeholders,
- knowing quality attributes and their trade-offs,
- specifying architecturally significant requirements in quality attribute scenarios,
- analysing design decisions with respect to their effects on quality attributes and stake-holder interests and concerns,
- presenting and documenting architectures by means of suitable views, notations and tools,
- applying methods (like RESTful API design) and tools in order to implement design decisions,
- using cloud resources like virtual machines, containers and storages in order to operate a system in the cloud,

in order to

- be able to produce long-term usable software systems in subsequent lectures and projects and
- to be able to act as an IT architect, e.g. in an IT department of a larger enterprise.



**Module Contents****Lecture / Exercises**

- Formally sound handling of quality requirements for availability, performance, capacity and cost efficiency
- Advantages and disadvantages of basic system architecture styles, such as microservice architectures
- Scaling of systems and individual tiers, also with regard to possible deployment strategies such as canary or AB deployment, as well as associated load balancing strategies (e.g. consistent hashing)
- Advanced applications of virtualization, in particular container virtualization and orchestration, for example with Docker and Kubernetes
- Selection of suitable communication patterns and protocols, in particular HTTP and derivatives such as websockets, server-sent events and gRPC
- Selection of appropriate API technologies and design philosophies such as REST and GraphQL
- Use of basic security protocols such as TLS, OAuth2, JWT and OpenID Connect
- Asynchronous, event-driven communication via messaging and streaming platforms such as Apache Kafka
- Selection of suitable database models (relational, key-value-, graph-, document-oriented), necessary consistency level, as well as sharding using the example of PostgreSQL, Neo4J, Apache Cassandra and Redis
- Strategies for caching data, in particular HTTP responses (web caching).

**Project**

- Be able to formulate and present a research question in the topic area of the course.
- Design an application prototype that serves to investigate the research question.
- Develop the application prototype and run it in the cloud
- Design and conduct test scenarios and experiments with the application prototype to answer the research question.

|                                      |                                                                                            |
|--------------------------------------|--------------------------------------------------------------------------------------------|
| <b>Teaching and Learning Methods</b> | <ul style="list-style-type: none"> <li>▪ Lecture / Exercises</li> <li>▪ Project</li> </ul> |
|--------------------------------------|--------------------------------------------------------------------------------------------|

|                                       |                      |
|---------------------------------------|----------------------|
| <b>Examination Types with Weights</b> | cf. exam regulations |
|---------------------------------------|----------------------|

|                 |           |
|-----------------|-----------|
| <b>Workload</b> | 150 Hours |
|-----------------|-----------|

|                      |                      |
|----------------------|----------------------|
| <b>Contact Hours</b> | 45 Hours $\pm$ 4 SWS |
|----------------------|----------------------|

|                   |           |
|-------------------|-----------|
| <b>Self-Study</b> | 105 Hours |
|-------------------|-----------|

|                                  |                                                                                                                                                                                                                                                                                           |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Recommended Prerequisites</b> | <ul style="list-style-type: none"> <li>- advanced programming skills</li> <li>- basic knowledge of web technologies</li> <li>- basic knowledge of databases</li> <li>- basic knowledge in software architectures</li> <li>- basic knowledge of Unified Modeling Language (UML)</li> </ul> |
|----------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                                |                                                         |
|--------------------------------|---------------------------------------------------------|
| <b>Mandatory Prerequisites</b> | Project requires attendance in the amount of: 4 Termine |
|--------------------------------|---------------------------------------------------------|

|                               |                                                                                                                                                                                                                                                                                                                                                                         |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Recommended Literature</b> | <ul style="list-style-type: none"> <li>▪ Lecture Notes Large and Cloud-based Software Systems</li> <li>▪ H. Adkins et al.: Building Secure and Reliable Systems, O'Reilly Media, 2020</li> <li>▪ I. Gregorik: High Performance Browser Networking, O'Reilly Media, 2013</li> <li>▪ M. Kleppmann: Designing Data-Intensive Applications, O'Reilly Media, 2017</li> </ul> |
|-------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                                                  |                                                                                                                                                                                                                               |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Use of the Module in Other Study Programs</b> | <ul style="list-style-type: none"> <li>▪ LCSS in Master Communication Systems and Networks 2024</li> <li>▪ LCSS in Master Medientechnologie 2024</li> <li>▪ LCSS in Master Informatik und Systems-Engineering 2024</li> </ul> |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                                        |                            |
|----------------------------------------|----------------------------|
| <b>Permanent Links to Organization</b> | <a href="#">llu course</a> |
|----------------------------------------|----------------------------|

**Specifics and Notes**

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**Last Update**

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## 6.20 MAA - Masterarbeit

|                             |                                                                                          |
|-----------------------------|------------------------------------------------------------------------------------------|
| <b>Module ID</b>            | MAA_MaTIN2020                                                                            |
| <b>Module Name</b>          | Masterarbeit                                                                             |
| <b>Type of Module</b>       | Mandatory Module                                                                         |
| <b>Recognized Course</b>    | MAA - Master thesis                                                                      |
| <b>ECTS credits</b>         | 27                                                                                       |
| <b>Language</b>             | deutsch, englisch bei Bedarf                                                             |
| <b>Duration of Module</b>   | 1 Semester                                                                               |
| <b>Recommended Semester</b> | 3                                                                                        |
| <b>Frequency of Course</b>  | every term                                                                               |
| <b>Module Coordinator</b>   | Studiengangsleiter(in) Master Technische Informatik / Informatik und Systems-Engineering |
| <b>Lecturer(s)</b>          | verschiedene Dozenten*innen / diverse lecturers                                          |

### Learning Outcome(s)

Das Modul vermittelt folgende Kenntnisse und Fertigkeiten:

- Komplexe Aufgabenstellungen beurteilen
- Selbstständiges Verfassen eines längeren wissenschaftlichen Textes
- Gute Praxis des wissenschaftlichen Arbeitens anwenden
- Darstellung von Forschungsergebnissen in Form eines wissenschaftlichen Artikels nach den Vorgaben gängiger Fachzeitschriften bzw. Konferenzen
- Selbstständiges und systematisches Bearbeiten einer komplexen ingenieurwissenschaftlichen Aufgabenstellung unter Verwendung wissenschaftlicher Methoden
- Lösungsstrategien entwickeln und umsetzen
- Wissenschaftliche Literatur recherchieren und auswerten
- Eigene Arbeit bewerten und einordnen

Individuelle Vereinbarung des Studierenden mit einem Dozenten der MT bzw. F07 über eine qualifizierte Ingenieurtätigkeit mit einer studiengangsbezogenen Aufgabenstellung mit wissenschaftlichem Anspruch. Die Masterarbeit kann auch extern in einer Forschungsorganisation, einem Wirtschaftsunternehmen o.ä. durchgeführt werden. Die Betreuung erfolgt durch den Dozenten. Die Masterarbeit adressiert die Entwicklung komplexer Medientechnologien unter interdisziplinären Bedingungen (HF1) und das wissenschaftliche Arbeiten um wissenschaftliche Erkenntnisse zu erweitern (HF2)."

### Module Contents

#### Thesis

The Master's thesis is a written assignment. It should show that the student is capable of independently working on a topic from his or her subject area within a specified period of time, both in its technical details and in its interdisciplinary contexts, using scientific and practical methods. Interdisciplinary cooperation can also be taken into account in the final thesis.

|                                       |                                      |
|---------------------------------------|--------------------------------------|
| <b>Teaching and Learning Methods</b>  | Thesis                               |
| <b>Examination Types with Weights</b> | cf. exam regulations                 |
| <b>Workload</b>                       | 810 Hours                            |
| <b>Contact Hours</b>                  | 0 Hours $\pm$ 0 SWS                  |
| <b>Self-Study</b>                     | 810 Hours                            |
| <b>Recommended Prerequisites</b>      | See examination regulations §26      |
| <b>Mandatory Prerequisites</b>        | see exam regulations §26 paragraph 1 |

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**Recommended Literature**

|                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Use of the Module in Other Study Programs</b> | <ul style="list-style-type: none"><li>▪ MAA in Master Communication Systems and Networks 2020</li><li>▪ MAA in Master Communication Systems and Networks 2024</li><li>▪ MAA in Master Elektrotechnik 2020</li><li>▪ MAA in Master Elektrotechnik und Informationstechnik 2024</li><li>▪ MAA in Master Medientechnologie 2020</li><li>▪ MAA in Master Medientechnologie 2024</li><li>▪ MAA in Master Informatik und Systems-Engineering 2024</li></ul> |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

|                            |                                                                                                                                |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------|
| <b>Specifics and Notes</b> | See also examination regulations §24ff. Contact a professor of the faculty early on for the initial supervision of the thesis. |
|----------------------------|--------------------------------------------------------------------------------------------------------------------------------|

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| <b>Last Update</b> | 19.7.2025, 14:32:16 |
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## 6.21 MCI - Mensch-Computer-Interaktion

|                             |                                               |
|-----------------------------|-----------------------------------------------|
| <b>Module ID</b>            | MCI_MaTIN2020                                 |
| <b>Module Name</b>          | Mensch-Computer-Interaktion                   |
| <b>Type of Module</b>       | Elective Modules                              |
| <b>Recognized Course</b>    | MCI - Human Computer Interaction              |
| <b>ECTS credits</b>         | 5                                             |
| <b>Language</b>             | deutsch, englisch bei Bedarf                  |
| <b>Duration of Module</b>   | 1 Semester                                    |
| <b>Recommended Semester</b> | 1-2                                           |
| <b>Frequency of Course</b>  | every summer term                             |
| <b>Module Coordinator</b>   | Prof. Dr. Jonas Schild/Professor Fakultät IME |
| <b>Lecturer(s)</b>          | Prof. Dr. Jonas Schild/Professor Fakultät IME |

### Learning Outcome(s)

#### WAS:

Das Modul vermittelt folgende Kenntnisse und Fertigkeiten:

- Grundlagen der Mensch-Computer-Interaktion: Definitionen, Normen, Modelle, Prinzipien
- Interaktive Systeme aus Hard- und Software konzipieren, implementieren und analysieren
- User Experience verstehen und Prinzipien des UX Engineerings anwenden
- Wiss. Fragestellungen vor einem Forschungshintergrund der HCI entwickeln
- Geeignete Nutzerstudien nach wiss. und ethischen Kriterien konzipieren, planen und durchführen
- statistische und deskriptive Daten wissenschaftlich analysieren, veranschaulichen und diskutieren
- in heterogenen Teams zusammenarbeiten, sich koordinieren und präsentieren

#### WOMIT:

Die Kompetenzen werden zunächst über eine Vorlesung durch die Dozenten vermittelt und danach im Praktikum anhand konkreter Aufgabenstellung von den Studierenden vertieft. Im seminaristischen Teil der Lehrveranstaltung recherchieren die Studierenden zu vorgegebenen Themen anhand von Fachartikeln und weiteren Informationsquellen über neue Konzepte der Mensch-Computer Interaktion und stelle diese dar in einer Präsentation dar.

#### WOZU:

Die Studierenden erlernen das eigenständige Durchführen von Forschungsprozesse auf dem Gebiet der Mensch-Computer-Interaktion, um im interdisziplinären Team auf Grundlage von selbst entwickelten komplexen, interaktiven Systemen (HF1) aktuelle Fragestellungen aus dem Bereich der Mensch-Computer-Interaktion wissenschaftlich untersuchen (HF2) und dabei die Effektivität und Wirkung von interaktiven Systemen auf Nutzende testen und einschätzen zu können (HF4).

**Module Contents****Lecture**

Models and design principles of interactive systems  
 Principles of context-, task- and user-oriented development of interactive systems  
 Basics of barrier-free access to interactive systems  
 Relevant standards and guidelines: EN ISO 9241, ISO 14915, HHS  
 Control options: Dedicated input/output devices, voice control, gesture control  
 Best Practices and Style Guides: Desktop / Web / Mobile / Hybrid Applications  
 Usability evaluation (analytical/empirical, heuristics, expert interviews, focus groups, user studies)  
 Evaluation methods (thinking aloud, eye-tracking, (semi-)structured interviews)

Experimental Research: Research Question, Hypotheses, Errors of 1st and 2nd Kind  
 Experiment Design: Between Group, Within Group, Split-Plot, Reliability of Experimental Results  
 Statistical analysis: scale levels, descriptive statistics, T-tests, ANOVA, regression, correlation  
 Surveys: sampling and sample selection, sources of error, questionnaires, evaluation of surveys

**Lab**

Capturing and understanding textual tasks  
 Recording tasks and creating models from them  
 Implementing UI components on the basis of the models created  
 Testing and securing developments  
 Checking and evaluating work results of comolitions  
 Applying MCI research methods and terminology

**Seminar**

**Teaching and Learning Methods**

- Lecture
- Lab
- Seminar

**Examination Types with Weights** cf. exam regulations

**Workload** 150 Hours

**Contact Hours** 45 Hours  $\pm$  4 SWS

**Self-Study** 105 Hours

**Recommended Prerequisites** none

**Mandatory Prerequisites**

- Lab requires attendance in the amount of: 2 Termine
- Seminar requires attendance in the amount of: Vorträge und Schlusspräsentation

**Recommended Literature**

- A. M. Heinecke: Mensch-Computer-Interaktion, Basiswissen für Entwickler und Gestalter, 2. Auflage, Springer, 2011
- B. Shneiderman, C. Plaisant: Designing the User Interface: Strategies for Effective Human-Computer Interaction, Addison Wesley, 2009
- S. Swink: Game Feel: A Game Designer's Guide to Virtual Sensation, Morgan Kaufmann Game Design Books, 2008
- T. Sylvester: Designing Games: A Guide to Engineering Experiences, O'Reilly, 2013
- J. Lazar, J.H. Feng, H. Hochheiser, Research Methods in Human-Computer-Interaction, Wiley, 2012

**Use of the Module in Other Study Programs**

- MCI in Master Medientechnologie 2020
- MCI in Master Medientechnologie 2024
- MCI in Master Informatik und Systems-Engineering 2024

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**Specifics and Notes**

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## 6.22 MLWR - Maschinelles Lernen und wissenschaftliches Rechnen

|                             |                                                    |
|-----------------------------|----------------------------------------------------|
| <b>Module ID</b>            | MLWR_MaTIN2020                                     |
| <b>Module Name</b>          | Maschinelles Lernen und wissenschaftliches Rechnen |
| <b>Type of Module</b>       | Elective Modules                                   |
| <b>Recognized Course</b>    | MLWR - Machine Learning and Scientific Computing   |
| <b>ECTS credits</b>         | 5                                                  |
| <b>Language</b>             | deutsch                                            |
| <b>Duration of Module</b>   | 1 Semester                                         |
| <b>Recommended Semester</b> | 1-2                                                |
| <b>Frequency of Course</b>  | every summer term                                  |
| <b>Module Coordinator</b>   | Prof. Dr. Beate Rhein/Professor Fakultät IME       |
| <b>Lecturer(s)</b>          | Prof. Dr. Beate Rhein/Professor Fakultät IME       |

### Learning Outcome(s)

Was:

fortgeschrittene Methoden des maschinellen Lernens auf typische Datensätze der technischen Informatik anwenden  
 Fallstricke des Maschinellen Lernens in der Vorgehensweise erkennen  
 für eine Aufgabenstellung das geeignete Verfahren bestimmen und anwenden können  
 Qualität von Datensätzen beurteilen und verbessern  
 Datenschutzgesetze kennen  
 weit verbreitete Software des maschinellen Lernens anwenden

Womit:

Die Methoden werden anhand eines Vortrags oder per Lernvideos vermittelt und in Vorlesung und Übung direkt angewendet. Jeder Student wird ein Projekt durchführen (je nach Anzahl der Studierenden in Gruppenarbeit), bei der er sich Teile des Stoffes selber erarbeitet.

Wozu:

Maschinelles Lernen wird bei den späteren Arbeitgebern immer mehr eingeführt, etwa in der Robotik, aber auch zur Überwachung und Steuerung von Produktionsprozessen oder Energiesystemen und zur Auswertung von Kundendaten, hier ist ein verantwortlicher Einsatz von Daten wichtig.



**Module Contents****Lecture / Exercises**

Approximation methods  
metamodeling  
regression

Multi-criteria optimization  
formulation  
Pareto front  
algorithms  
visualization

Advanced Cluster Analysis

Association Pattern Mining

Outlier Detection

Advanced classification procedures

possibly text recognition, web mining, time series analysis

**Lab**

Apply and program methods of approximation, multicriteria optimization or machine learning  
efficiently implement numerical methods  
Evaluate the complexity of algorithms

**Teaching and Learning Methods**

- Lecture / Exercises
- Lab

**Examination Types with Weights**

cf. exam regulations

**Workload** 150 Hours

**Contact Hours** 45 Hours  $\pm$  4 SWS

**Self-Study** 105 Hours

**Recommended Prerequisites**

Basic knowledge of probability theory and machine learning

**Mandatory Prerequisites**

- Lecture / Exercises requires attendance in the amount of: 6 Stunden
- Lab requires attendance in the amount of: 2 Termine
- Participation in final examination only after successful participation in Lab

**Recommended Literature**

- A. Geron: Hand-on Machine Learning, O'Reilly Verlag
- J. Alamar: Hands-on Large Language Models, O'Reilly Verlag

**Use of the Module in Other Study Programs**

- MLWR in Master Communication Systems and Networks 2020
- MLWR in Master Communication Systems and Networks 2024
- MLWR in Master Elektrotechnik 2020
- MLWR in Master Elektrotechnik und Informationstechnik 2024
- MLWR in Master Medientechnologie 2024
- MLWR in Master Informatik und Systems-Engineering 2024

**Specifics and Notes**

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## 6.23 NGN - Next Generation Networks

|                             |                                                |
|-----------------------------|------------------------------------------------|
| <b>Module ID</b>            | NGN_MaTIN2020                                  |
| <b>Module Name</b>          | Next Generation Networks                       |
| <b>Type of Module</b>       | Elective Modules                               |
| <b>Recognized Course</b>    | NGN - Next Generation Networks                 |
| <b>ECTS credits</b>         | 5                                              |
| <b>Language</b>             | englisch                                       |
| <b>Duration of Module</b>   | 1 Semester                                     |
| <b>Recommended Semester</b> | 1-2                                            |
| <b>Frequency of Course</b>  | every summer term                              |
| <b>Module Coordinator</b>   | Prof. Dr. Andreas Grebe/Professor Fakultät IME |
| <b>Lecturer(s)</b>          | Prof. Dr. Andreas Grebe/Professor Fakultät IME |

### Learning Outcome(s)

What?

Understanding architectures and service signalling in Next Generation Networks (All-IP Networks). Competences to evaluate, analyze, design, implement and test NGN components and service areas with heterogeneous service requirements.

How?

Based on Bachelor-level competences on IP networking and services, students learn standards, design principles, architectures and sample implementations of Next Generation Networks and services in lectures and exercises. In a small team and organized as semester project, students develop their own NGN service solution, optionally based on existing systems, and learn how to design, implement and analyze their own service solution.

What for?

To be able to design, analyze, select, use and apply actual and future network services, based on All-IP networks for enterprise networks, telecommunication networks and mobile networks.

### Module Contents

#### Lecture / Exercises

Achieve basic understanding and implementation knowledge on Next Generation Network (NGN) definition by ITU-T, IP Multimedia Subsystem by 3GPP, and ETSI, and Next Generation Internet (NGI) definition by IETF, ITU-T standards, Multimedia Services in NGN, VoIP, Video-over-IP, RTP encapsulation, Service Signaling, SIP protocol, SIP Digest Authentication, SDP service description and capabilities, SIP servers, Session Border Controller (SBC), SIP Gateway Technologies, SIP routing, NAT Gateways, NAT solution, SRR, STUN, TURN, IMS in mobile networks, IMS in fixed-line networks, VoIP in enterprise networks. IMS in virtualized core network.

Students evaluate requirements for NGN services and plan, implement and analyze NGN services based on SIP signalling or alternative signalling protocols. They are competent in functional analysis and troubleshooting by deep packet inspection (DPI) protocol analysis. They evaluate the performance of NGN services in terms of timing, throughput, latency and delays, jitter, robustness in case of packet errors, and security aspects.

#### Lab

Naming, structuring and classifying concepts and technologies for NGNs or NGIs. Demonstrate network analysis techniques and tools, know methods for NGN services and network planning.

Working on a small project in a tiny team (2-3 team members) on actual technologies in the area of NGN services and NGI services. Set-up an NGN/NGI environment and NGN service, including planning, implementation and evaluation of security aspects and protocol analysis plus performance evaluation.

The results are reviewed during the course period, summarised in a report and presented to the class. Individual project proposals by students are welcome.

|                                      |                                                                                        |
|--------------------------------------|----------------------------------------------------------------------------------------|
| <b>Teaching and Learning Methods</b> | <ul style="list-style-type: none"> <li>■ Lecture / Exercises</li> <li>■ Lab</li> </ul> |
|--------------------------------------|----------------------------------------------------------------------------------------|

|                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Examination Types with Weights</b>            | cf. exam regulations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Workload</b>                                  | 150 Hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Contact Hours</b>                             | 45 Hours $\pm$ 4 SWS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Self-Study</b>                                | 105 Hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Recommended Prerequisites</b>                 | <ul style="list-style-type: none"> <li>▪ Modul BSN: Bachelor Level Networking Knowledge and Skills like taught in BSN. Fundamentals of Networks and Protocols (typically Bachelor Level) Layered Communications and Protocol Stacks (ISO/OSI, IETF TCP/IP, IEEE), LAN, MAN, WAN, Fixed Line and Mobile Network Fundamentals, Data Link-Technologies (Ethernet, WiFi), IP-Networking (IPv4, IPv6), IP Routing Protocols (static Routes, RIP, OSPF, BGP), Transport Protocols (TCP (incl. Flow Control / Congestion Control), UDP) and Port Numbers, Application Protocols (HTTP, Request-Response Pattern, Publish-Subscribe Pattern).</li> <li>▪ Bachelor-level knowledge of protocols and layer models, Internet protocols (UDP, TCP, IP, HTTP, FTP), IP addressing (IPv4, IPv6), routing techniques (IP routing, functionality of a router, routing protocols, RIP, OSPF), transmission systems and layer 2 protocols, Ethernet. Understanding distributed systems and applications, sockets and client/server programming, request-response patterns, publish-subscribe patterns.</li> </ul> |
| <b>Mandatory Prerequisites</b>                   | <ul style="list-style-type: none"> <li>▪ Lab requires attendance in the amount of: 6 Meilensteintermine und Projektvorstellungen</li> <li>▪ Participation in final examination only after successful participation in Lab</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Recommended Literature</b>                    | <ul style="list-style-type: none"> <li>▪ J. Kurose, K. Ross: Computer Networking: A Top-Down Approach, Global Edition, Prentice Hall, 7th ed., 2016</li> <li>▪ A. S. Tanenbaum, D. J. Wetherall: Computer Networks, Pearson, 5th ed., 2013</li> <li>▪ U. Trick, F. Weber: SIP und Telekommunikationsnetze: Next Generation Networks und Multimedia over IP – konkret, De Gruyter Oldenbourg Verlag, 4. Auflage 2015</li> <li>▪ J. F. Durkin: Voice-enabling the Data Network, Cisco Press 2010</li> <li>▪ G. Camarillo, M.A. García-Martín: The 3G IP Multimedia Subsystem (IMS), John Wiley Verlag, 2006</li> <li>▪ W. Stallings: Foundations of Modern Networking, Pearson Education, 2016</li> <li>▪ J. Doherty: SDN and NFV Simplified, Pearson Education, 2016</li> <li>▪ J. Edelman: Network Programmability and Automation, O'Reilly 2018</li> <li>▪ J. van Meggelen, R. Bryant, L. Madsen: Asterisk: The Definitive Guide: Open Source Telephony for the Enterprise, O'Reilly Media, 5th Ed. 2019</li> </ul>                                                                            |
| <b>Use of the Module in Other Study Programs</b> | <ul style="list-style-type: none"> <li>▪ NGN in Master Communication Systems and Networks 2020</li> <li>▪ NGN in Master Communication Systems and Networks 2024</li> <li>▪ NGN in Master Informatik und Systems-Engineering 2024</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Specifics and Notes</b>                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Last Update</b>                               | 19.7.2025, 14:32:16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

## 6.24 PAP - Parallele Programmierung

|                             |                                                        |
|-----------------------------|--------------------------------------------------------|
| <b>Module ID</b>            | PAP_MaTIN2020                                          |
| <b>Module Name</b>          | Parallele Programmierung                               |
| <b>Type of Module</b>       | Elective Modules                                       |
| <b>Recognized Course</b>    | PAP - Parallel Programming                             |
| <b>ECTS credits</b>         | 5                                                      |
| <b>Language</b>             | deutsch, englisch bei Bedarf                           |
| <b>Duration of Module</b>   | 1 Semester                                             |
| <b>Recommended Semester</b> | 1-2                                                    |
| <b>Frequency of Course</b>  | every summer term                                      |
| <b>Module Coordinator</b>   | Prof. Dr.-Ing. Arnulph Fuhrmann/Professor Fakultät IME |
| <b>Lecturer(s)</b>          | Prof. Dr.-Ing. Arnulph Fuhrmann/Professor Fakultät IME |

### Learning Outcome(s)

Medientechnische und interaktive Systeme beinhalten rechenintensive Berechnungen. Um Anforderungen an die Verarbeitung in Echtzeit erfüllen zu können, sind daher Kompetenzen und Wissen über die Grundlagen für die Analyse (HF1, HF2), den Entwurf (HF1, HF2), die Implementierung (HF1, HF2) und die Bewertung (HF1, HF2) paralleler Computerprogramme erforderlich.

Folgende Kenntnisse und Kompetenzen werden im Detail vermittelt:

- Grundlegende Konzepte, Modelle und Technologien der parallel Verarbeitung benennen, strukturieren, einordnen und abgrenzen
- Aufgabenstellungen in Bezug auf die Programmierung paralleler Programme analysieren und strukturieren, einschlägige parallele Hardwarearchitektur zuordnen und auf Paralleldesign übertragen
- Parallele Programme unter Einsatz geeigneter Tools analysieren und Ergebnisse nachvollziehbar darstellen
- Leistungsfähigkeit paralleler Programme abschätzen und analysieren
- Information aus englischen Originalquellen und Standards ableiten

Kenntnisse und Basisfertigkeiten werden in der Vorlesung vermittelt. Begleitend dazu werden in den Übungen Kompetenzen und Fertigkeiten ausgebaut und inhaltliche Themen vertieft.

### Module Contents

#### Lecture

- Basic concepts, models and technologies of parallel processing (parallelism, concurrency, SISD, SIMD, MISD, MIMD, loose- and closely coupled systems, distributed systems)
- Parallel performance measures (speedup, efficiency)
- Architecture of GPUs
- Parallel Algorithms for GPUs

#### Exercises / Lab

- Analyze and structure tasks related to programming parallel programs, assign relevant parallel hardware architecture and transfer to parallel design
- Implement parallel programs (multicore hardware with threads and GPUs)
- Analyze parallel programs using suitable tools and present results in a comprehensible way
- Estimate and analyze performance of parallel programs
- Derive information from original English sources and standards

|                                      |                                                                                        |
|--------------------------------------|----------------------------------------------------------------------------------------|
| <b>Teaching and Learning Methods</b> | <ul style="list-style-type: none"> <li>▪ Lecture</li> <li>▪ Exercises / Lab</li> </ul> |
|--------------------------------------|----------------------------------------------------------------------------------------|

|                                       |                      |
|---------------------------------------|----------------------|
| <b>Examination Types with Weights</b> | cf. exam regulations |
|---------------------------------------|----------------------|

|                 |           |
|-----------------|-----------|
| <b>Workload</b> | 150 Hours |
|-----------------|-----------|

|                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Contact Hours</b>                             | 45 Hours $\triangleq$ 4 SWS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Self-Study</b>                                | 105 Hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Recommended Prerequisites</b>                 | The exercises require programming knowledge and the use of console-oriented programs in Linux-based operating systems.                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Mandatory Prerequisites</b>                   | Exercises / Lab requires attendance in the amount of: 2 Termine                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Recommended Literature</b>                    | <ul style="list-style-type: none"><li>▪ Wen-mei W. Hwu, David B. Kirk, Izzat El Hajj: Programming Massively Parallel Processors A Hands-on Approach - 4th Edition, 2022</li><li>▪ Andrew S. Tanenbaum, Herbert Bos: Modern Operating Systems, 4th Edition, 2015</li><li>▪ Jason Sanders: CUDA by Example: An Introduction to General-Purpose GPU Programming, Addison-Wesley Longman, 2010</li><li>▪ R. Oechsle: Parallele und verteilte Anwendungen in Java, Hanser, 2011</li><li>▪ P. Pacheco: An Introduction to Parallel Programming, Morgan Kaufmann, 2011</li></ul> |
| <b>Use of the Module in Other Study Programs</b> | <ul style="list-style-type: none"><li>▪ PAP in Master Medientechnologie 2020</li><li>▪ PAP in Master Medientechnologie 2024</li><li>▪ PAP in Master Informatik und Systems-Engineering 2024</li></ul>                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Specifics and Notes</b>                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Last Update</b>                               | 19.7.2025, 14:32:16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |

## 6.25 PHTM - Philosophische Handlungstheorie Master

|                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                                                                          |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Module ID</b>                                                                                                                                                                                                                                                                                                                                                                                                                           | PHTM_MaTIN2020                                                                                                                                                                                           |
| <b>Module Name</b>                                                                                                                                                                                                                                                                                                                                                                                                                         | Philosophische Handlungstheorie Master                                                                                                                                                                   |
| <b>Type of Module</b>                                                                                                                                                                                                                                                                                                                                                                                                                      | Elective Modules                                                                                                                                                                                         |
| <b>Recognized Course</b>                                                                                                                                                                                                                                                                                                                                                                                                                   | PHTM - Philosophical theory of action                                                                                                                                                                    |
| <b>ECTS credits</b>                                                                                                                                                                                                                                                                                                                                                                                                                        | 5                                                                                                                                                                                                        |
| <b>Language</b>                                                                                                                                                                                                                                                                                                                                                                                                                            | deutsch                                                                                                                                                                                                  |
| <b>Duration of Module</b>                                                                                                                                                                                                                                                                                                                                                                                                                  | 1 Semester                                                                                                                                                                                               |
| <b>Recommended Semester</b>                                                                                                                                                                                                                                                                                                                                                                                                                | 1-2                                                                                                                                                                                                      |
| <b>Frequency of Course</b>                                                                                                                                                                                                                                                                                                                                                                                                                 | every winter term                                                                                                                                                                                        |
| <b>Module Coordinator</b>                                                                                                                                                                                                                                                                                                                                                                                                                  | Prof. Dr. Gregor Büchel/Professor Fakultät IME im Ruhestand                                                                                                                                              |
| <b>Lecturer(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                         | Prof. Dr. Gregor Büchel/Professor Fakultät IME im Ruhestand                                                                                                                                              |
| <b>Learning Outcome(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                          |
| <ul style="list-style-type: none"> <li>▪ (WAS) Studierende wenden philosophischen Theorien auf Probleme des Handelns in der heutigen Gesellschaft an,</li> <li>▪ (WOMIT) indem Sie zentrale philosophische Texte studieren, seminaristisch aufarbeiten und präsentieren,</li> <li>▪ (WOZU) um ihr späteres gesellschaftliches und berufliches Handeln auf philosophisch und ethisch durchdachten Grundlagen aufbauen zu können.</li> </ul> |                                                                                                                                                                                                          |
| <b>Module Contents</b>                                                                                                                                                                                                                                                                                                                                                                                                                     |                                                                                                                                                                                                          |
| <b>Lecture</b>                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                          |
| The background of philosophical theories of action is "illuminated" in the lecture                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                          |
| <b>Seminar</b>                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                          |
| The seminar will focus on the following five texts by Immanuel Kant:                                                                                                                                                                                                                                                                                                                                                                       |                                                                                                                                                                                                          |
| <ol style="list-style-type: none"> <li>1. "Answering the Question: What is Enlightenment?" 1 "Ideas for a General History with a Cosmopolitan Intention", 1 "Groundwork for the Metaphysics of Morals",</li> <li>2. the antinomy of freedom and natural necessity in the "Critique of Pure Reason", 1 "On Perpetual Peace".</li> </ol>                                                                                                     |                                                                                                                                                                                                          |
| Aspects of the philosophical theory of action given in these texts are to be applied to problems of action in today's society.                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                          |
| <b>Teaching and Learning Methods</b>                                                                                                                                                                                                                                                                                                                                                                                                       | <ul style="list-style-type: none"> <li>▪ Lecture</li> <li>▪ Seminar</li> </ul>                                                                                                                           |
| <b>Examination Types with Weights</b>                                                                                                                                                                                                                                                                                                                                                                                                      | cf. exam regulations                                                                                                                                                                                     |
| <b>Workload</b>                                                                                                                                                                                                                                                                                                                                                                                                                            | 150 Hours                                                                                                                                                                                                |
| <b>Contact Hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                       | 34 Hours $\pm$ 3 SWS                                                                                                                                                                                     |
| <b>Self-Study</b>                                                                                                                                                                                                                                                                                                                                                                                                                          | 116 Hours                                                                                                                                                                                                |
| <b>Recommended Prerequisites</b>                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                                                                          |
| <b>Mandatory Prerequisites</b>                                                                                                                                                                                                                                                                                                                                                                                                             | <ul style="list-style-type: none"> <li>▪ Seminar requires attendance in the amount of: 6 Termine</li> <li>▪ Participation in final examination only after successful participation in Seminar</li> </ul> |

**Recommended Literature**

- Immanuel Kant: „Beantwortung der Frage: Was ist Aufklärung? Und andere kleine Schriften“, Berlin (Sammlung Hoffenberg), 2016, ISBN: 978-3-8430-9208-1
- Immanuel Kant: „Schriften zur Geschichtsphilosophie“, Stuttgart (Reclam), 2013, ISBN: 978-3-15-009694-9
- Immanuel Kant: „Grundlegung zur Metaphysik der Sitten“, Stuttgart (Reclam), 2016, ISBN: 978-3-15-004507-7
- Immanuel Kant: „Kritik der reinen Vernunft“, Stuttgart (Reclam), 1966, ISBN: 978-3-15-006461-0
- Immanuel Kant: „Zum ewigen Frieden“, Stuttgart (Reclam), 2012, ISBN: 978-3-15-001501-8

**Use of the Module in Other Study Programs**

PHTM in Master Informatik und Systems-Engineering 2024

**Specifics and Notes**

**Last Update**

19.7.2025, 14:32:16

## 6.26 PLET - Projektleitung

|                             |                                                                                                                                                              |
|-----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Module ID</b>            | PLET_MaTIN2020                                                                                                                                               |
| <b>Module Name</b>          | Projektleitung                                                                                                                                               |
| <b>Type of Module</b>       | Elective Modules                                                                                                                                             |
| <b>Recognized Course</b>    | PLET - Project management                                                                                                                                    |
| <b>ECTS credits</b>         | 5                                                                                                                                                            |
| <b>Language</b>             | deutsch                                                                                                                                                      |
| <b>Duration of Module</b>   | 1 Semester                                                                                                                                                   |
| <b>Recommended Semester</b> | 1-2                                                                                                                                                          |
| <b>Frequency of Course</b>  | every winter term                                                                                                                                            |
| <b>Module Coordinator</b>   | Prof. Dr. Michael Gartz/Professor Fakultät IME                                                                                                               |
| <b>Lecturer(s)</b>          | <ul style="list-style-type: none"> <li>▪ Prof. Dr. Michael Gartz/Professor Fakultät IME</li> <li>▪ Prof. Dr. Uwe Oberheide/Professor Fakultät IME</li> </ul> |

### Learning Outcome(s)

Was: Die Studierenden haben organisatorische Kompetenz erworben und können Projekt planen, durchführen, dokumentieren, Produktanforderungen analysieren, Machbarkeit bewerten und Produktqualität planen. Sie können Projektstrukturpläne und Projektzeitpläne erstellen, Projektmeilensteine planen, Projektrisiken erkennen und mildern. Sie können den Einsatz von Personal und Sachressource planen, Reviews planen, Produktverifikation planen.

Die Studierenden haben Projektführungskompetenz erworben und können die Projektsteuerung mit agilen, evolutionären Vorgehensmodellen und dem Timeboxmodell durchführen. Sie können Projektmanagementwerkzeuge einsetzen, den Projektfortschritt überwachen / steuern und Projektergebnisse freigeben. Sie können den Entwicklungsprozess fortlaufend optimieren in unklaren Situationen entscheiden. Sie können den Entwicklungsverlauf dokumentieren, Projektberichte verfassen und verteidigen.

Die Studierenden haben Personalführungskompetenz erworben und können Aufgaben auf Teammitglieder nach individuellen Qualifikationen und Neigungen verteilen.

Sie können die Teambildung fördern, das Team koordinieren und zielorientiert und respektvoll kommunizieren und verbindliche Absprachen treffen und einfordern. Sie können Teamprozesse moderieren, potenzielle Konfliktsituationen erkennen und auflösen und Handlungsalternativen abwägen.

Womit: indem sie die in dem Teamleiter Seminar erlernten Kompetenzen und Fertigkeiten und die in dem Projektleiter-Workshop erlernten Projektleitungs-Tools und Kompetenzen anwenden.

Wozu: um später in den verschiedensten Industriebereichen Projekte mittels agilen, evolutionären Vorgehensmodellen, wie z.B. SCRUM, zu planen, durchzuführen, zu managen und zum Erfolg zu bringen.



## Module Contents

### Seminar

Classifying and delimiting terms  
explain characteristic properties of development projects  
Goal orientation and innovation  
Risk of failure  
Special organisational form (teamwork)  
Limited resources  
Limited realization time  
abstractly define technical and economic goals in development projects  
abstractly define, explain and justify project management tasks  
identify and explain basic success and failure factors in project management  
unexpected technical problems  
insufficient staff qualification  
unclear or conflicting requirements  
poor project management  
Insufficient support from senior management  
identify extended challenges arising from a division of labour in project processing  
explain selected process models  
linear models for business project management  
phase model  
V-model  
agile process models for technical project management  
SCRUM  
timebox model  
classify and compare process models with regard to development duration, organizational aspects, quality and cost aspects  
professional quality control  
Cost and schedule control in business management  
Legal requirements for documentation and traceability of project decisions  
characterize basic tasks and expected results in development projects  
Planning and control of product quality  
Planning and controlling the quality of the development process  
overarching legal requirements  
industry-specific specifications  
company-internal specifications  
project risk management  
resource management  
Documentation of the development process  
Specification of the requirements for the product to be developed  
Specification of the product design  
Product development and manufacturing  
product documentation  
Verification and validation of the developed product  
Product release and product monitoring  
Characterize instruments for controlling team processes  
plan essential management tasks, milestones and project documents with regard to the course element "Project  
carry out essential management tasks mentally and identify project risks with foresight  
handle essential project management tools in a target-oriented manner  
for project (time) planning  
for requirement specifications  
Planning team building procedures, deriving expected challenges and meaningful measures

identify potential conflict situations in the team and discuss alternative actions

### Project

#### Lead team

explain to the team members the basic procedure in the project  
Capturing and classifying the competencies of team members  
agree on goals in terms of content and deadlines

#### Project management

derive requirements specification in the team from the project order  
and prioritize requirements  
Create and maintain project plan  
Identify project risks and plan meaningful mitigation measures, e.g. early feasibility studies  
Create and maintain project schedule  
Rough planning of tasks  
Plan process  
Planning effort, appointments, rooms  
Plan Project Reviews  
apply agile process model in conjunction with Timebox model to ensure a minimal project success  
Define a minimum goal that can be achieved by the team.  
define extended goals for fast teams  
Drafting a final project report  
Document and evaluate results  
Document and evaluate the project process

#### Lead team

Monitoring and controlling goal achievement  
Coordinate collaboration between team members  
Recognizing and resolving conflict situations within the team

#### Project management

Planning and managing project sections  
plan tasks for the next phase of the project in detail  
and assign them meaningfully to the team members  
Plan and moderate content reviews with team members  
Evaluate project results in the team  
Modify the project section plan and, if necessary, the project plan according to the project procedure.  
evaluate the approach of the current project phase retrospectively and, if necessary, modify it for the next project phase.  
Document project sections  
plan access to shared laboratory resources  
computer  
tools  
special workstations and measuring stations  
special test environments  
Prepare project decisions in the team

**Teaching and Learning**    ■ Seminar  
**Methods**                      ■ Project

**Examination Types with**    cf. exam regulations  
**Weights**

**Workload**                      150 Hours

**Contact Hours**               23 Hours  $\pm$  2 SWS

**Self-Study**                     127 Hours

|                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Recommended Prerequisites</b>                 | basic knowledge of project management<br>basic experience as a member of project teams                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Mandatory Prerequisites</b>                   | <ul style="list-style-type: none"><li>▪ Project requires attendance in the amount of: 8 Termine</li><li>▪ Participation in final examination only after successful participation in Project</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Recommended Literature</b>                    | <ul style="list-style-type: none"><li>▪ Hans-D. Litke, „Projektmanagement, Methoden, Techniken, Verhaltensweisen, Evolutionäres Projektmanagement“, Hanser</li><li>▪ Ken Schwaber: Agiles Projektmanagement mit Scrum (Microsoft Press)</li><li>▪ Litke, Kunow, Schulz-Wimmer, „Projekt-Management“, Taschenguide , Haufe</li><li>▪ Stefan Kreiser, Skripte der Vorlesung Software Engineering f.d. Automatisierungstechnik: „Projektmanagement, Vorgehensmodelle“, ILIAS</li><li>▪ Stanley E.Portny, „Projektmanagement für Dummies“, Wiley</li><li>▪ Marcus Heidbrink, „Das Projektteam“, Haufe</li><li>▪ Video Tutorial für SCRUM: <a href="http://www.video2brain.com/de/videotraining/agile-softwareentwicklung-mit-scrum">http://www.video2brain.com/de/videotraining/agile-softwareentwicklung-mit-scrum</a></li></ul> |
| <b>Use of the Module in Other Study Programs</b> | <ul style="list-style-type: none"><li>▪ PLET in Master Elektrotechnik 2020</li><li>▪ PLET in Master Elektrotechnik und Informationstechnik 2024</li><li>▪ PLET in Master Informatik und Systems-Engineering 2024</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Specifics and Notes</b>                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Last Update</b>                               | 22.8.2025, 10:17:37                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

## 6.27 PLSYP - Projektleitung Systementwicklungs-Projekt

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                  |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------|
| <b>Module ID</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | PLSYP_MaTIN2020                                  |
| <b>Module Name</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Projektleitung Systementwicklungs-Projekt        |
| <b>Type of Module</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Elective Modules                                 |
| <b>Recognized Course</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | SYP - System Development Project                 |
| <b>ECTS credits</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | 5                                                |
| <b>Language</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | deutsch                                          |
| <b>Duration of Module</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 1 Semester                                       |
| <b>Recommended Semester</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | 1-2                                              |
| <b>Frequency of Course</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | every winter term                                |
| <b>Module Coordinator</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Prof. Dr. René Wörzberger/Professor Fakultät IME |
| <b>Lecturer(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Prof. Dr. René Wörzberger/Professor Fakultät IME |
| <b>Learning Outcome(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                  |
| <ul style="list-style-type: none"> <li>▪ Studierende leiten ein Team von Systementwicklungs-Projekt-Teilnehmenden (SYP) an</li> <li>▪ indem sie               <ul style="list-style-type: none"> <li>▪ ein interessantes und geeignetes Entwicklungs-Thema ausarbeiten,</li> <li>▪ die Fortschritte des Teams über den gesamten Entwicklungsprozess überwachen,</li> <li>▪ regelmäßige Status-Meetings mit den Teammitgliedern abhalten</li> <li>▪ der Gesamtprojektleitung regelmäßig in weiteren Status-Meetings berichten</li> </ul> </li> <li>▪ um (später) in einem (beruflichen) Umfeld Verantwortung für die (technische) Leitung eines Entwicklungsprojekts übernehmen zu können.</li> </ul> |                                                  |
| <b>Module Contents</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |                                                  |
| <b>Lab</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                  |
| <ul style="list-style-type: none"> <li>team-oriented software development</li> <li>communication with customers</li> <li>coverage of whole software lifecycle</li> <li>organize project regarding schedule and content</li> <li>give presentations</li> <li>develop schedule for development project</li> <li>elicit and document customer requirements</li> <li>specify and model system according to requirements</li> <li>design system according to specification and quality requirements</li> <li>implement system</li> <li>document technical system details</li> <li>verify implemented system</li> <li>create user documentation</li> <li>present own solutions to customers</li> </ul>     |                                                  |
| <b>Teaching and Learning Methods</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Lab                                              |
| <b>Examination Types with Weights</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | cf. exam regulations                             |
| <b>Workload</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 150 Hours                                        |
| <b>Contact Hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 12 Hours $\pm$ 1 SWS                             |

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|-------------------|-----------|
| <b>Self-Study</b> | 138 Hours |
|-------------------|-----------|

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|----------------------------------|--|
| <b>Recommended Prerequisites</b> |  |
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|                                |                                                     |
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| <b>Mandatory Prerequisites</b> | Lab requires attendance in the amount of: 5 Termine |
|--------------------------------|-----------------------------------------------------|

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|-------------------------------|---------------------------------------------------------|
| <b>Recommended Literature</b> | <ul style="list-style-type: none"><li>▪ keine</li></ul> |
|-------------------------------|---------------------------------------------------------|

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|--------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Use of the Module in Other Study Programs</b> | <ul style="list-style-type: none"><li>▪ SYP in Bachelor Technische Informatik 2020</li><li>▪ SYP in Bachelor Informatik und Systems-Engineering 2024</li><li>▪ PLSYP in Master Informatik und Systems-Engineering 2024</li></ul> |
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|----------------------------------------|-----------------------------------|
| <b>Permanent Links to Organization</b> | <a href="#"><u>Ilu course</u></a> |
|----------------------------------------|-----------------------------------|

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| <b>Specifics and Notes</b> |  |
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| <b>Last Update</b> | 19.7.2025, 14:32:16 |
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**6.28 QEKS - Qualitätsgesteuerter Entwurf komplexer Softwaresysteme**

|                             |                                                        |
|-----------------------------|--------------------------------------------------------|
| <b>Module ID</b>            | QEKS_MaTIN2020                                         |
| <b>Module Name</b>          | Qualitätsgesteuerter Entwurf komplexer Softwaresysteme |
| <b>Type of Module</b>       | Elective Modules                                       |
| <b>Recognized Course</b>    | SEKM - Software Engineering by Components and Pattern  |
| <b>ECTS credits</b>         | 5                                                      |
| <b>Language</b>             | deutsch und englisch                                   |
| <b>Duration of Module</b>   | 1 Semester                                             |
| <b>Recommended Semester</b> | 1-2                                                    |
| <b>Frequency of Course</b>  | every winter term                                      |
| <b>Module Coordinator</b>   | Prof. Dr. Stefan Kreiser/Professor Fakultät IME        |
| <b>Lecturer(s)</b>          | Prof. Dr. Stefan Kreiser/Professor Fakultät IME        |

**Learning Outcome(s)**

Studierende sind im Hinblick auf die Qualität eines Softwaresystems in der Lage:

- zur vorhersagbaren, effizienten Entwicklung eines Softwaresystems bzw. einer Softwarearchitektur zielgerichtet angemessene Wiederverwendungsstrategien und professionelle Modellierungs- und Entwicklungswerkzeuge sowie den Rahmenbedingungen insgesamt angemessene Projektstrukturen einzusetzen.
  - die Softwarearchitektur für komplexe, verteilte Automatisierungssysteme unter Berücksichtigung der spezifischen Anforderungen hinsichtlich der besonderen Zielsetzung des jeweiligen Automatisierungssystems zu analysieren, zu konzipieren, zu entwerfen, zu implementieren, zu prüfen und zu bewerten.
  - die besonderen Anforderungen an die Servicequalität, an die Einsatzumgebung und die organisatorischen Rahmenbedingungen für die Entwicklung, die sich aus dem Entwicklungsprozess und einem angemessenen Lebenszyklusmanagement ergeben, zu erkennen und im Hinblick auf ihre Relevanz für die Softwarearchitektur des Automatisierungssystems zu analysieren und zu bewerten.
-

**Module Contents****Lecture / Exercises**

Terminology  
value vs. cost of a technical software  
distributed software system, concurrency  
software quality, quality of service, refactoring  
complexity (algorithmic, structural), emergence  
re-use, symmetry and symmetry operations, abstraction, invariants  
quality controlled re-use, methodical approaches  
variants of white box re-use  
black box re-use  
grey box re-use (hierarchical approach to re-use)  
re-use in automation control software systems  
determinism  
benefits and challenges  
tailoring process models and personnel structures in projects  
meet requirements in development projects predictably (product quality, cost, deadlines)  
distributed development, maintenance and support of software systems  
software pattern  
pattern description using UML  
essential architectural pattern  
construction pattern  
structural pattern  
behavioural pattern  
class based (static) vs. object based (dynamic) pattern  
essential pattern for concurrent and networked real time systems  
encapsulation and role based extension of layered architectures  
concurrency structures to optimize throughput and system response latency  
distributed event processing  
process synchronisation  
construction and use of pattern catalogues, pattern languages  
pattern based design of complex software systems  
components and frameworks  
design principles  
interface architecture  
active and passive system elements  
design, programming and test  
quality  
configuration and use  
using middleware systems to develop architectures of technical software systems  
ORB architectures, e.g. CORBA and TAO  
integrated system platforms, e.g. MS .NET  
multi agent systems (MAS)  
agent architectural models  
collaboration between agents  
agent languages  
considering cases for MAS application

use pattern to design complex software systems  
extract and discuss purpose, limitation of use, invariant and configurable parts of pattern from english and german literature sources  
understand implementation skeletons of pattern and map them to problem settings with limited technical focus  
discuss benefits of using object oriented programming languages  
derive recurrent settings in the development of complex software systems  
implement pattern on exemplary settings and test resulting implementations  
reasonably combine pattern to solve recurring problem settings with a broader technical focus  
use UML2 notations  
use professional UML2 IDE for round-trip-engineering  
integrate software system based on exemplary implementations of the pattern to combine  
conduct integration test, assess software quality and optimize software system

construct black-box-components based on pattern  
analyse component based software architectures  
derive suitable scope from architectural specs  
understand and discuss development process to construct software systems  
find active and passive system elements and derive system run time behaviour  
understand abstract system interfaces to interconnect, configure and activate components  
understand abstract system interfaces to exchange applicational run time data  
understand system extension points (functional and structural system configuration layer)  
analyse distribution architectures  
understand basic system services (describe and reason service usage, relate to system tasks)  
relate pattern to structure making architectural software artefacts  
derive suitable range of applications for a given distribution architecture  
understand engineering process to construct user applications (application layer)  
discuss attributes and limitation of usage of interconnection protocols  
find designated system extension points  
compare MAS to conventional distribution architectures  
agent vs. component  
architectural models  
activation of agents  
deployment of agents  
protocols for interconnection and collaboration  
range of applications and and limitation of usage

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### **Seminar**

challenging seminar topics can be defined e.g. from the following or related subject areas

- reusable artifacts for building the architecture of distributed software systems,
- professional distribution architectures,
- Multiagent systems,
- special economic, liability and ethical requirements for software systems with (distributed) artificial intelligence and their effects on the design of software architectures

present personal work results and work results of the team in a compact and target-group-oriented way, both orally and in writing

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### **Project**

Develop software artifact of a distribution architecture for complex software systems  
Carry out project planning in distributed teams with an agile process model  
Perform extensive system analysis with respect to the role of the artifact in the distribution architecture  
Determine design input requirements for the development of the artifact  
Specify and model the software artifact based on the design input requirements  
Select and justify design principles and patterns to achieve defined quality objectives  
Derive interfaces, behavioral and structural models iteratively based on patterns in UML2 notations  
Use professional UML2 design tool purposefully  
Verify and evaluate models, correct model errors and optimize models  
Programming software artifacts in C++  
define meaningful test scenarios and verify software artifacts  
Evaluate the quality of the software artifact  
Present the team's project results to a professional audience in a compact and target-group-oriented way

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**Teaching and Learning**   ▪ Lecture / Exercises  
**Methods**                    ▪ Seminar  
                                  ▪ Project

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**Examination Types with Weights**   cf. exam regulations

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**Workload**                   150 Hours

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**Contact Hours**           57 Hours  $\pm$  5 SWS

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**Self-Study**                93 Hours

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|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Recommended Prerequisites</b>                 | <ul style="list-style-type: none"><li>■ Modul PLET: oder aus einem (naturwissenschaftlich-technischen) Bachelorstudium: - grundlegende Kenntnisse in (agilem) Projektmanagement</li><li>■ - programming skills in an object-oriented programming language, preferably C++</li><li>- knowledge of software modeling using Unified Modeling Language (UML) or other (formal) languages that support modeling of interfaces, behavior and structures</li><li>- basic knowledge in (agile) project management, SCRUM oder XP</li><li>- basic knowledge of essential software architectural models</li><li>- basic knowledge of interconnection models in software systems (OSI, TCP/IP, Messaging)</li></ul>                                                                                                                                                                                                                                                                                                      |
| <b>Mandatory Prerequisites</b>                   | <ul style="list-style-type: none"><li>■ Project requires attendance in the amount of: 3 Termine</li><li>■ Participation in final examination only after successful participation in Project</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Recommended Literature</b>                    | <ul style="list-style-type: none"><li>■ D. Schmidt et.al.: Pattern-Oriented Software Architecture. Patterns for Concurrent and Networked Objects (Wiley)</li><li>■ Gamma et.al.: Design Patterns, (Addison-Wesley)</li><li>■ Martin Fowler: Refactoring, Engl. ed. (Addison-Wesley Professional)</li><li>■ U. Hammerschall: Verteilte Systeme und Anwendungen (Pearson Studium)</li><li>■ Andreas Andresen: Komponentenbasierte Softwareentwicklung m. MDA, UML2, XML (Hanser Verlag)</li><li>■ T. Ritter et. al.: CORBA Komponenten. Effektives Software-Design u. Progr. (Springer)</li><li>■ Bernd Oestereich: Analyse und Design mit UML 2.5 (Oldenbourg)</li><li>■ OMG Unified Modeling Language Spec., <a href="http://www.omg.org/um">www.omg.org/um</a></li><li>■ I. Sommerville: Software Engineering (Addison-Wesley / Pearson Studium)</li><li>■ K. Beck: eXtreme Programming (Addison-Wesley Professional)</li><li>■ Ken Schwaber: Agiles Projektmanagement mit Scrum (Microsoft Press)</li></ul> |
| <b>Use of the Module in Other Study Programs</b> | <ul style="list-style-type: none"><li>■ QEKS in Master Elektrotechnik 2020</li><li>■ QEKS in Master Elektrotechnik und Informationstechnik 2024</li><li>■ QEKS in Master Informatik und Systems-Engineering 2024</li></ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Specifics and Notes</b>                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Last Update</b>                               | 19.7.2025, 14:32:16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |

## 6.29 THI - Theoretische Informatik

|                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                                                                                                                                                                                                                                                                                                                                                                            |
|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Module ID</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | THI_MaTIN2020                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Module Name</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Theoretische Informatik                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Type of Module</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | Mandatory Module                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Recognized Course</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | THI - Theoretical Computer Science                                                                                                                                                                                                                                                                                                                                                         |
| <b>ECTS credits</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | 5                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Language</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | deutsch                                                                                                                                                                                                                                                                                                                                                                                    |
| <b>Duration of Module</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | 1 Semester                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Recommended Semester</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 1                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Frequency of Course</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | every summer term                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Module Coordinator</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Prof. Dr. Hubert Randerath/Professor Fakultät IME                                                                                                                                                                                                                                                                                                                                          |
| <b>Lecturer(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | Prof. Dr. Hubert Randerath/Professor Fakultät IME                                                                                                                                                                                                                                                                                                                                          |
| <b>Learning Outcome(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                            |
| <p>(WAS) Die Studierenden erlernen formale Grundlagen der Informatik (WOMIT) indem Sie</p> <ul style="list-style-type: none"> <li>- den Umgang mit Typ2, Typ1 und Typ0-Sprachen erlernen und formale Maschinen konstruieren, die Sprachen des jeweiligen Typs erkennen,</li> <li>- mit formalen Modellen der Informatik arbeiten,</li> <li>- Kenntnisse der Berechenbarkeits, Entscheidbarkeits- und Komplexitätstheorie auf praktische Probleme anwenden,</li> <li>- einen präzisen Algorithmenbegriff verwenden, um die Tragweite von Algorithmen zu beschreiben und die Komplexität von Algorithmen zu bestimmen,</li> <li>- die prinzipielle Lösbarkeit algorithmischer Probleme untersuchen,</li> </ul> <p>(WOZU) um in Forschungsergebnisse in späteren Lehrveranstaltungen und Abschlussarbeiten auf ein solides theoretisches Fundament stellen zu können.</p> |                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Module Contents</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Lecture / Exercises</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |                                                                                                                                                                                                                                                                                                                                                                                            |
| <p>An algorithm's complexity can be determined by analyzing its input and the algorithmic core, e.g., by means of the O-notation. The analysis might consist of a polynomial reduction of a known hard problem like the satisfiability problem in propositional logic of the unknown problem.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Teaching and Learning Methods</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | Lecture / Exercises                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Examination Types with Weights</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  | cf. exam regulations                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Workload</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | 150 Hours                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Contact Hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   | 34 Hours $\pm$ 3 SWS                                                                                                                                                                                                                                                                                                                                                                       |
| <b>Self-Study</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | 116 Hours                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Recommended Prerequisites</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Basics in automata theory and formal languages                                                                                                                                                                                                                                                                                                                                             |
| <b>Mandatory Prerequisites</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>Recommended Literature</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <ul style="list-style-type: none"> <li>■ Theoretische Grundlagen der Informatik, Rolf Socher, Hanser Verlag</li> <li>■ Theoretische Informatik, Juraj Hromkovic, Teubner-Verlag</li> <li>■ Grundkurs Theoretische Informatik, Gottfried Vossen und Kurt-Ulrich Witt, Vieweg-Verlag</li> <li>■ Theoretische Informatik - kurzgefasst, Uwe Schöning, Spektrum Akademischer Verlag</li> </ul> |

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|------------------------------------------------------|-------------------------------------------------------|
| <b>Use of the Module in<br/>Other Study Programs</b> | THI in Master Informatik und Systems-Engineering 2024 |
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**Specifics and Notes**

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| <b>Last Update</b> | 19.7.2025, 14:32:16 |
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### 6.30 VAE - Virtual Acoustic Environments

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|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------|
| <b>Module ID</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | VAE_MaTIN2020                                                                                 |
| <b>Module Name</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Virtual Acoustic Environments                                                                 |
| <b>Type of Module</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | Elective Modules                                                                              |
| <b>Recognized Course</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        | VAE - Virtual Acoustic Environments (VAE)                                                     |
| <b>ECTS credits</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | 5                                                                                             |
| <b>Language</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | englisch                                                                                      |
| <b>Duration of Module</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | 1 Semester                                                                                    |
| <b>Recommended Semester</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     | 1-2                                                                                           |
| <b>Frequency of Course</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      | every summer term                                                                             |
| <b>Module Coordinator</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Prof. Dr.-Ing. Christoph Pörschmann/Professor Fakultät IME                                    |
| <b>Lecturer(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              | Prof. Dr.-Ing. Christoph Pörschmann/Professor Fakultät IME                                    |
| <b>Learning Outcome(s)</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                               |
| <p>What: The students learn the basic concepts , the technology and perception-related aspects of virtual acoustic environments. The course will be strongly related to research aspects and projects</p> <p>How: The students apply their knowledge on Signal Processing, Audio, and in the field of VR on different aspects of Virtual Acoustic Environments. Actual trends in research and state of the art applications will be integrated, tested, analyzed and evaluated.</p> <p>Aim: The students shall be able to work on research topics which consider topics which are scientifically new and relevant. Aspects of scalability and commercialization play a role</p> |                                                                                               |
| <b>Module Contents</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |                                                                                               |
| <b>Lecture</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                               |
| The basic concepts of headphone-based or loudspeaker-based VR-systems are introduced                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                               |
| <b>Project</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                               |
| In one specific topic of Virtual Acoustic Environments the students shall get deep know-how on the technology and apply it to a practical problem and present the results                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |                                                                                               |
| <b>Lab</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |                                                                                               |
| <b>Teaching and Learning Methods</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | <ul style="list-style-type: none"> <li>▪ Lecture</li> <li>▪ Project</li> <li>▪ Lab</li> </ul> |
| <b>Examination Types with Weights</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           | cf. exam regulations                                                                          |
| <b>Workload</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | 150 Hours                                                                                     |
| <b>Contact Hours</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | 45 Hours $\pm$ 4 SWS                                                                          |
| <b>Self-Study</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | 105 Hours                                                                                     |
| <b>Recommended Prerequisites</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                | Know-how on Acoustics and audio signal processing                                             |
| <b>Mandatory Prerequisites</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                               |

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**Recommended  
Literature**

- Rozinska, A. "Immersive Sound"
- Blauert, J. "Spatial Hearing"
- Zotter, F., Frank, M. "Ambisonics: A Practical 3D Audio Theory for Recording, Studio Production, Sound Reinforcement, and Virtual Reality"

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**Use of the Module in  
Other Study Programs**

- VAE in Master Communication Systems and Networks 2020
- VAE in Master Communication Systems and Networks 2024
- VAE in Master Medientechnologie 2020
- VAE in Master Medientechnologie 2024
- VAE in Master Informatik und Systems-Engineering 2024

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**Specifics and Notes**

**Last Update**

19.7.2025, 14:32:16

### 6.31 VER - Virtuelle und erweiterte Realität

|                             |                                                                                                                                                                         |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Module ID</b>            | VER_MaTIN2020                                                                                                                                                           |
| <b>Module Name</b>          | Virtuelle und erweiterte Realität                                                                                                                                       |
| <b>Type of Module</b>       | Elective Modules                                                                                                                                                        |
| <b>Recognized Course</b>    | VER - Virtual and Augmented Reality                                                                                                                                     |
| <b>ECTS credits</b>         | 5                                                                                                                                                                       |
| <b>Language</b>             | deutsch, englisch bei Bedarf                                                                                                                                            |
| <b>Duration of Module</b>   | 1 Semester                                                                                                                                                              |
| <b>Recommended Semester</b> | 1-2                                                                                                                                                                     |
| <b>Frequency of Course</b>  | every winter term                                                                                                                                                       |
| <b>Module Coordinator</b>   | Prof. Dr.-Ing. Arnulph Fuhrmann/Professor Fakultät IME                                                                                                                  |
| <b>Lecturer(s)</b>          | <ul style="list-style-type: none"> <li>▪ Prof. Dr.-Ing. Arnulph Fuhrmann/Professor Fakultät IME</li> <li>▪ Prof. Dr. Stefan Grünvogel/Professor Fakultät IME</li> </ul> |

#### Learning Outcome(s)

##### WAS:

Das Modul vermittelt folgende Kenntnisse und Fertigkeiten:

- Virtual- und Augmented-Reality-Anwendungen konzipieren, aufbauen und bewerten
- Interaktions und Navigationsverfahren erstellen
- Basistechnologien der virtuellen und erweiterten Reality weiterentwickeln
- Werkzeuge und Methoden zur Entwicklung von VR/AR-Anwendungen verwenden
- Algorithmische und mathematische Grundlagen von VR/AR anwenden

##### WOMIT:

Die Kompetenzen werden zunächst über eine Vorlesung durch die Dozenten vermittelt und danach im Praktikum anhand konkreter Aufgabenstellung von den Studierenden vertieft. Im seminaristischen Teil der Lehrveranstaltung recherchieren die Studierenden zu vorgegebenen Themen anhand von Fachartikeln und weiteren Informationsquellen über neue Konzepte der virtuellen und erweiterten Realität und stelle diese dar in einer Präsentation dar.

##### WOZU:

Die sichere Anwendung der Grundlagen der virtuellen und erweiterten Realität ist Voraussetzung für die Entwicklung komplexer interaktiver medientechnischer Systeme (HF1). Weiterhin erlaubt das Grundlagenwissen die Bewertung bestehender Systeme und das wissenschaftliche Arbeiten in diesem Gebiet (HF2).

**Module Contents****Lecture**

- Explain terms from the field of virtual and augmented reality
- Explain and compare data structures and algorithms for VR/AR applications
- 3D data formats
- Spatial data structures
- Describing Multimodal User Interfaces
- Selection of 3D objects
- Manipulation of 3D objects
- Navigation in virtual scenes
- system control
- Describe input and output devices and specific virtual and augmented reality hardware
- display technologies
- Stereo Displays
- Autostereoscopic Displays
- projection solutions
- Wearable Displays
- Head Mounted Displays
- Handheld Displays
- See-through Displays
- Workbench
- Cave
- Tiled Displays
- 3D-Audio
- Force Feedback Devices
- Haptic feedback
- input devices
- controller
- data gloves
- locomotion devices
- Explain algorithmic and mathematical basics
- stereoscopy
- tracking
- capture of position and orientation: Degrees of freedom
- tracking technologies
- Mechanical
- Optical
- Electromagnetic
- ultrasound
- inertial
- eye tracking
- head tracking
- object tracking
- Markerless Tracking
- Marker-Based Tracking
- rendering
- management of large 3D scenes
- haptic rendering
- stereo rendering
- real-time rendering
- collision detection
- intersections between primitives
- Discrete and continuous collision detection
- acceleration data structures
- collision response

**Lab**

- Design, build and evaluate virtual environments and augmented reality applications
  - Creating Interaction and Navigation Procedures
  - Further develop fundamental technologies of virtual and augmented reality
  - Use tools and methods to implement VR/AR applications
  - Apply algorithmic and mathematical principles of VR/AR
  - understand and grasp textual tasks
  - Testing and debugging your own application
- 

**Seminar**

Apply Algorithmic and Mathematical fundamentals  
Check interaction and navigation procedures  
Independently obtaining and summarizing scientific literature  
Present and discuss new concepts of virtual and augmented reality

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|                                      |                                                                                           |
|--------------------------------------|-------------------------------------------------------------------------------------------|
| <b>Teaching and Learning Methods</b> | <ul style="list-style-type: none"><li>▪ Lecture</li><li>▪ Lab</li><li>▪ Seminar</li></ul> |
|--------------------------------------|-------------------------------------------------------------------------------------------|

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|                                       |                      |
|---------------------------------------|----------------------|
| <b>Examination Types with Weights</b> | cf. exam regulations |
|---------------------------------------|----------------------|

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|                 |           |
|-----------------|-----------|
| <b>Workload</b> | 150 Hours |
|-----------------|-----------|

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|                      |                      |
|----------------------|----------------------|
| <b>Contact Hours</b> | 45 Hours $\pm$ 4 SWS |
|----------------------|----------------------|

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|                   |           |
|-------------------|-----------|
| <b>Self-Study</b> | 105 Hours |
|-------------------|-----------|

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|                                  |                                         |
|----------------------------------|-----------------------------------------|
| <b>Recommended Prerequisites</b> | Computer Graphics<br>Computer Animation |
|----------------------------------|-----------------------------------------|

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|                                |                                                     |
|--------------------------------|-----------------------------------------------------|
| <b>Mandatory Prerequisites</b> | Lab requires attendance in the amount of: 2 Termine |
|--------------------------------|-----------------------------------------------------|

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|                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Recommended Literature</b> | <ul style="list-style-type: none"><li>▪ R. Dörner et al., Virtual und Augmented Reality (VR/AR): Grundlagen und Methoden der Virtuellen und Augmentierten Realität, Springer Vieweg, 2019</li><li>▪ Schmalstieg und Höllerer, Augmented Reality – Principles and Practice, Addison Wesley, 2016</li><li>▪ T. Akenine-Möller, et al., Real-Time Rendering Fourth Edition, Taylor &amp; Francis Ltd., 2018</li><li>▪ J. Jerald, The VR Book: Human-Centered Design for Virtual Reality, Acm Books, 2015</li></ul> |
|-------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

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|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Use of the Module in Other Study Programs</b> | <ul style="list-style-type: none"><li>▪ VER in Master Medientechnologie 2020</li><li>▪ VER in Master Medientechnologie 2024</li><li>▪ VER in Master Informatik und Systems-Engineering 2024</li></ul> |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|

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**Specifics and Notes**

|                    |                     |
|--------------------|---------------------|
| <b>Last Update</b> | 19.7.2025, 14:32:16 |
|--------------------|---------------------|

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### 6.32 XIM - Fachübergreifende Kompetenzen und Soft Skills

|                                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
|--------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Module ID</b>                                 | XIM_MaTIN2020                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Module Name</b>                               | Fachübergreifende Kompetenzen und Soft Skills                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Type of Module</b>                            | Elective Modules                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| <b>Recognized Course</b>                         | XPSS - Practically based Summer School                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |
| <b>ECTS credits</b>                              | 5                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Language</b>                                  | englisch                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| <b>Duration of Module</b>                        | 1 Semester                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Recommended Semester</b>                      | 1-2                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
| <b>Frequency of Course</b>                       | every summer term                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
| <b>Module Coordinator</b>                        | Prof. Dr. Rainer Bartz/Professor Fakultät IME                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Lecturer(s)</b>                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Learning Outcome(s)</b>                       | <p>Die Studierenden lernen, über die fachbezogenen Grenzen ihres Studiums hinweg zu schauen. Sie sind in der Lage, internationale, inter/transdisziplinäre und/oder interkulturelle Aspekte ihres zukünftigen Berufs zu erkennen, einzuordnen, ihr Verhalten darauf einzustellen und auch in fremdem Kontext sicher zu agieren. Das konkrete Lehrangebot wird in der Regel erst kurzfristig zu Beginn des jeweiligen Semesters festgelegt. Es kann unterschiedlichste Themen behandeln; eine Zusammenarbeit mit anderen Fakultäten oder Institutionen ist vorgesehen. Je nach konkret gewähltem Lehrangebot werden die u.a. Kompetenzen unterschiedlich intensiv vermittelt. Das Modul kann auch durch Teilnahme an mehreren verschiedenen kleineren Lehrveranstaltungen erfüllt werden, sofern diese zu den Modulzielen beitragen und die erforderlichen ECTS-Punkte in Summe erreicht sind.</p> |
| <b>Module Contents</b>                           |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Project</b>                                   | <p>Working in small teams, self organisation, project planing, project realisation, presentation</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Teaching and Learning Methods</b>             | Project                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Examination Types with Weights</b>            | cf. exam regulations                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Workload</b>                                  | 150 Hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Contact Hours</b>                             | 12 Hours $\pm$ 1 SWS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |
| <b>Self-Study</b>                                | 138 Hours                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |
| <b>Recommended Prerequisites</b>                 | Good knowledge in programming microcontroller. Good understanding of electronic elements and electronic components. Experience or skill in developing electronic circuits.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| <b>Mandatory Prerequisites</b>                   |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Recommended Literature</b>                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |
| <b>Use of the Module in Other Study Programs</b> | <ul style="list-style-type: none"> <li>■ XPSS in Bachelor Elektrotechnik 2020</li> <li>■ XPSS in Bachelor Elektrotechnik und Informationstechnik 2024</li> <li>■ XPSS in Bachelor Technische Informatik 2020</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Specifics and Notes</b>                       | The Summer School will be offered together with collaborating universities. A fixed date can not be guaranteed. Informations to the start of the Summer School will be announced early.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |
| <b>Last Update</b>                               | 19.7.2025, 14:32:16                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |

## Additional module variant with same learning outcomes

|                             |                                               |
|-----------------------------|-----------------------------------------------|
| <b>Module ID</b>            | XIM_MaTIN2020                                 |
| <b>Module Name</b>          | Fachübergreifende Kompetenzen und Soft Skills |
| <b>Type of Module</b>       | Elective Modules                              |
| <b>Recognized Course</b>    | GER - Industrial property protection          |
| <b>ECTS credits</b>         | 5                                             |
| <b>Language</b>             | deutsch                                       |
| <b>Duration of Module</b>   | 1 Semester                                    |
| <b>Recommended Semester</b> | 1-2                                           |
| <b>Frequency of Course</b>  | every term                                    |
| <b>Module Coordinator</b>   | Prof. Dr. Rainer Bartz/Professor Fakultät IME |
| <b>Lecturer(s)</b>          | Ladrière                                      |

**Learning Outcome(s)**

Die Studierenden lernen, über die fachbezogenen Grenzen ihres Studiums hinweg zu schauen.

Sie sind in der Lage, internationale, inter/transdisziplinäre und/oder interkulturelle Aspekte ihres zukünftigen Berufs zu erkennen, einzuordnen, ihr Verhalten darauf einzustellen und auch in fremdem Kontext sicher zu agieren.

Das konkrete Lehrangebot wird in der Regel erst kurzfristig zu Beginn des jeweiligen Semesters festgelegt. Es kann unterschiedlichste Themen behandeln; eine Zusammenarbeit mit anderen Fakultäten oder Institutionen ist vorgesehen.

Je nach konkret gewähltem Lehrangebot werden die u.a. Kompetenzen unterschiedlich intensiv vermittelt.

Das Modul kann auch durch Teilnahme an mehreren verschiedenen kleineren Lehrveranstaltungen erfüllt werden, sofern diese zu den Modulzielen beitragen und die erforderlichen ECTS-Punkte in Summe erreicht sind.

**Module Contents****Lecture**

Types of industrial property rights, significance for companies and inventors, significance of employee invention law and inventor personality law, prerequisites for protection, term of industrial property rights, structure of an application, life cycle from application to patent, subsequent applications, examination and opposition procedures, national, European and international applications, utility models, trademarks, design, law on the protection of secrets, professional field of patent engineer.

Carry out a patent search; determine the relevant type of protective right for a given case; be able to correctly file an application with regard to its formal structure; weigh up the advantages and disadvantages of national, European and international applications in a specific application; check the validity of a patent; develop a basic IP strategy.

**Seminar**

Types of industrial property rights, significance for companies and inventors, significance of employee invention law and inventor personality law, prerequisites for protection, term of industrial property rights, structure of an application, life cycle from application to patent, subsequent applications, examination and opposition procedures, national, European and international applications, utility models, trademarks, design, law on the protection of secrets, professional field of patent engineer.

Carry out a patent search; determine the relevant type of protective right for a given case; be able to correctly file an application with regard to its formal structure; weigh up the advantages and disadvantages of national, European and international applications in a specific application; check the validity of a patent; develop a basic IP strategy.

|                                      |                                                                                |
|--------------------------------------|--------------------------------------------------------------------------------|
| <b>Teaching and Learning Methods</b> | <ul style="list-style-type: none"> <li>■ Lecture</li> <li>■ Seminar</li> </ul> |
|--------------------------------------|--------------------------------------------------------------------------------|

|                                       |                      |
|---------------------------------------|----------------------|
| <b>Examination Types with Weights</b> | cf. exam regulations |
|---------------------------------------|----------------------|

|                      |                             |
|----------------------|-----------------------------|
| <b>Workload</b>      | 150 Hours                   |
| <b>Contact Hours</b> | 34 Hours $\triangleq$ 3 SWS |

|                                                  |                                                                                                                                                             |
|--------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Self-Study</b>                                | 116 Hours                                                                                                                                                   |
| <b>Recommended Prerequisites</b>                 |                                                                                                                                                             |
| <b>Mandatory Prerequisites</b>                   |                                                                                                                                                             |
| <b>Recommended Literature</b>                    |                                                                                                                                                             |
| <b>Use of the Module in Other Study Programs</b> | <ul style="list-style-type: none"> <li>ERMK in Master Elektrotechnik und Informationstechnik 2024</li> <li>ERMK in Master Medientechnologie 2024</li> </ul> |
| <b>Specifics and Notes</b>                       |                                                                                                                                                             |
| <b>Last Update</b>                               | 19.7.2025, 14:32:16                                                                                                                                         |

### Additional module variant with same learning outcomes

|                             |                                                  |
|-----------------------------|--------------------------------------------------|
| <b>Module ID</b>            | XIM_MaTIN2020                                    |
| <b>Module Name</b>          | Fachübergreifende Kompetenzen und Soft Skills    |
| <b>Type of Module</b>       | Elective Modules                                 |
| <b>Recognized Course</b>    | PLSYP - Project Management for System Design Lab |
| <b>ECTS credits</b>         | 5                                                |
| <b>Language</b>             | deutsch, englisch bei Bedarf                     |
| <b>Duration of Module</b>   | 1 Semester                                       |
| <b>Recommended Semester</b> | 1-2                                              |
| <b>Frequency of Course</b>  | every winter term                                |
| <b>Module Coordinator</b>   | Prof. Dr. Rainer Bartz/Professor Fakultät IME    |
| <b>Lecturer(s)</b>          | Prof. Dr. René Wörzberger/Professor Fakultät IME |

#### Learning Outcome(s)

Die Studierenden lernen, über die fachbezogenen Grenzen ihres Studiums hinweg zu schauen. Sie sind in der Lage, internationale, inter/transdisziplinäre und/oder interkulturelle Aspekte ihres zukünftigen Berufs zu erkennen, einzuordnen, ihr Verhalten darauf einzustellen und auch in fremdem Kontext sicher zu agieren. Das konkrete Lehrangebot wird in der Regel erst kurzfristig zu Beginn des jeweiligen Semesters festgelegt. Es kann unterschiedlichste Themen behandeln; eine Zusammenarbeit mit anderen Fakultäten oder Institutionen ist vorgesehen. Je nach konkret gewähltem Lehrangebot werden die u.a. Kompetenzen unterschiedlich intensiv vermittelt. Das Modul kann auch durch Teilnahme an mehreren verschiedenen kleineren Lehrveranstaltungen erfüllt werden, sofern diese zu den den Modulzielen beitragen und die erforderlichen ECTS-Punkte in Summe erreicht sind.

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**Module Contents**
**Project**

PLSYP participants (Master students) outline a project assignment as part of a project catalog suitable to be worked on by Bachelor students in the course "System Design Practicum". The assignment is to be formulated as a Power Point one-pager according to a provided template. PLSYP participants demonstrate that they can present the requirements and objectives of a complex project in an appealing way in a very limited space.

PLSYP participants offer at least one remote information session between mid-July and mid-September so that interested SYP participants can learn about the exact task at hand. PLSYP participants thus demonstrate that they can explain and sell their project ideas in detail.

PLSYP participants arrange regular meetings with assigned SYP participants to discuss requirements and progress. PLSYP participants are able to respond comprehensively to detailed questions about requirements, but without prejudging the SYP participants' own technical decisions.

PLSYP participants discuss advantages and disadvantages of different technical designs and implementations with SYP participants. They are able to reach consensus with SYP participants on the desired implementation variant.

PLSYP participants keep an eye on the schedule created by SYP participants, proactively address SYP participants in the event of major deviations, and attempt to identify and eliminate causes (unrealistic planning, unclear requirements, problems with the technical basis, etc.). In this way, they demonstrate that they can reliably perform even repetitive activities in project management.

PLSYP participants attend SYP milestone meetings, especially those in which SYP participants demonstrate their progress. They follow up on the presentations and ask specific questions.

PLSYP participants thoroughly review SYP participants' deliverables (documents and source code). They provide written feedback to the SYP participants, discuss it and check its implementation. In this way, they demonstrate how they can influence the quality of the product without working directly on it.

PLSYP participants provide the SYP module supervisor with an assessment of their SYP team's performance and can justify and defend it. (The actual assessment of the SYP team is ultimately done by the SYP module supervisor for reasons of examination law).

**Teaching and Learning**    Project**Methods****Examination Types with Weights**    cf. exam regulations**Workload**    150 Hours**Contact Hours**    12 Hours  $\pm$  1 SWS**Self-Study**    138 Hours**Recommended Prerequisites**    Previous participation in the systems design practicum or equivalent.**Mandatory Prerequisites**    Project requires attendance in the amount of: 3 Fachgespräche**Recommended Literature****Use of the Module in Other Study Programs****Permanent Links to Organization**    [llu](#)**Specifics and Notes**    The course is offered throughout the winter semester. **Participation in PLSYP depends in particular on whether sufficient SYP participants are interested and can therefore not be guaranteed.****Last Update**    19.7.2025, 14:32:16

## 7. Electives Catalogs

The following shows which modules can be selected in a particular elective area. The following notes and regulations apply to all elective areas:

- **When choosing modules from elective catalogs, the conditions formulated in Specializations also apply.**
- The semester in which elective modules of an elective catalog can typically be taken can be found in the study plans.
- As a rule, modules are only offered in either the summer or winter semester. This means that any required accompanying examination can only be taken in this semester. The summative examinations for modules in Faculty 07 are usually offered in the examination period after each semester.
- A completed module is recognized for a maximum of one elective area, even if it is listed in several elective areas.
- There is an admission restriction for some modules. More information on this can be found in the announcements on admission restrictions.
- Registration and admission to non-faculty modules are subject to deadlines and other conditions set by the faculty or university offering the module. Their admission cannot be guaranteed. Students must contact the relevant external lecturer in good time to find out whether they are allowed to take part in an external module and what they need to do to register and participate.
- Upon application, a suitable modules can be added to the elective area. Such an application must be submitted informally to the head of degree program at least four months before the planned participation in that module. The examination board decides on the acceptance of the application in consultation with the head of degree program and suitable teaching staff. A study achievement to be recognized
  - must fit in with the intended graduate profile of the degree program and contribute to its achievement,
  - must be oriented towards learning outcomes and must not serve solely to impart knowledge,
  - must correspond to the qualification level of a Master's degree program,
  - must represent a meaningful increase in competence against the background of the intended course of study,
  - must have been completed by an examination and
  - must not be identical in terms of content and learning outcomes to coursework that has already been completed.
- Modules are not listed below,
  - which in the past were only recognized for an elective catalog as part of individual recognition procedures or
  - which in the past were only recognized for an elective catalog as part of a stay abroad and the associated individual learning agreement.

### Stays abroad

- Students who have integrated a stay abroad into their studies and have completed coursework at a foreign university can have this recognized upon application and with the approval of the examination board.
- A Learning Agreement must be concluded with the Faculty's Recognition Officer before the start of the stay abroad. In particular, it is agreed for which mandatory modules or elective catalogs the coursework completed abroad will be recognized.

### 7.1 AUS - Auslandssemester

Hier werden an einer ausländischen Hochschule erbrachte Leistungen nach vorheriger Absprache anerkannt, wenn ihr Umfang dem eines Semesters entspricht. Das konkrete Lehrangebot richtet sich nach der ausländischen Hochschule.

## 7.2 VMT - Vertiefung Mathematik

Für dieses Wahlmodul stehen folgende Module zur Verfügung.

You must select modules of 5 ECTS credit points in total out of this catalog.

Modules of the faculty:

| Module ID | Module Name                                        | ECTS |
|-----------|----------------------------------------------------|------|
| HIM       | Advanced Mathematics                               | 5    |
| KOGA      | Kombinatorische Optimierung und Graphenalgorithmen | 5    |
| KRY       | Cryptography                                       | 5    |
| MLWR      | Maschinelles Lernen und wissenschaftliches Rechnen | 5    |

Modules of other faculties or universities:

| Affiliation           | Module Name            | ECTS |
|-----------------------|------------------------|------|
| TH Köln (Fakultät 10) | Multivariate Statistik | 6    |

### 7.3 VTI - Vertiefung Technische Informatik

You must select modules of 15 ECTS credit points in total out of this catalog.

Modules of the faculty:

| Module ID | Module Name                                              | ECTS |
|-----------|----------------------------------------------------------|------|
| AMC       | Advanced Multimedia Communications                       | 5    |
| AMS       | Special Aspects of Mobile Autonomous Systems             | 5    |
| ARP       | Alternative Rechnerarchitekturen und Programmiersprachen | 5    |
| CI        | Computational Intelligence                               | 5    |
| ESD       | Embedded Systems Design                                  | 5    |
| IIS       | Intelligent Information Systems                          | 5    |
| LCSS      | Large and Cloud-based Software-Systems                   | 5    |
| NGN       | Next Generation Networks                                 | 5    |
| QC        | Quantum Computing                                        | 5    |
| QEKs      | Qualitätsgesteuerter Entwurf komplexer Softwaresysteme   | 5    |

Modules of other faculties or universities:

| Affiliation           | Module Name                | ECTS |
|-----------------------|----------------------------|------|
| TH Köln (Fakultät 10) | Advanced Machine Learning  | 6    |
| Universität Köln      | Quantum Information Theory | 6    |

## 7.4 W - Allgemeiner Wahlbereich

You must select modules of 20 ECTS credit points in total out of this catalog.

This elective catalog particularly includes all modules from the following areas:

- Electives Catalog VTI - Vertiefung Technische Informatik
- Electives Catalog VMT - Vertiefung Mathematik

Modules from these other areas are printed normally in the following, original modules from this elective area are printed in bold.

Modules of the faculty:

| Module ID   | Module Name                                              | ECTS     |
|-------------|----------------------------------------------------------|----------|
| <b>ACC</b>  | <b>Advanced Channel Coding</b>                           | <b>5</b> |
| AMC         | Advanced Multimedia Communications                       | 5        |
| AMS         | Special Aspects of Mobile Autonomous Systems             | 5        |
| ARP         | Alternative Rechnerarchitekturen und Programmiersprachen | 5        |
| <b>AVT</b>  | <b>Audio- und Videotechnologien</b>                      | <b>5</b> |
| <b>AVV</b>  | <b>Algorithmen der Videosignalverarbeitung</b>           | <b>5</b> |
| CI          | Computational Intelligence                               | 5        |
| <b>CSO</b>  | <b>Computersimulation in der Optik</b>                   | <b>5</b> |
| <b>DLO</b>  | <b>Deep Learning und Objekterkennung</b>                 | <b>5</b> |
| <b>DMC</b>  | <b>Digital Motion Control</b>                            | <b>5</b> |
| <b>DSP</b>  | <b>Digital Signal Processing</b>                         | <b>5</b> |
| ESD         | Embedded Systems Design                                  | 5        |
| HIM         | Advanced Mathematics                                     | 5        |
| <b>IBD</b>  | <b>InnoBioDiv</b>                                        | <b>5</b> |
| IIS         | Intelligent Information Systems                          | 5        |
| <b>ITF</b>  | <b>IT-Forensik</b>                                       | <b>5</b> |
| KOGA        | Kombinatorische Optimierung und Graphenalgorithmen       | 5        |
| KRY         | Cryptography                                             | 5        |
| LCSS        | Large and Cloud-based Software-Systems                   | 5        |
| <b>MCI</b>  | <b>Mensch-Computer-Interaktion</b>                       | <b>5</b> |
| MLWR        | Maschinelles Lernen und wissenschaftliches Rechnen       | 5        |
| NGN         | Next Generation Networks                                 | 5        |
| <b>PAP</b>  | <b>Parallele Programmierung</b>                          | <b>5</b> |
| QC          | Quantum Computing                                        | 5        |
| QEKs        | Qualitätsgesteuerter Entwurf komplexer Softwaresysteme   | 5        |
| <b>QM</b>   | <b>Quantenmechanik</b>                                   | <b>5</b> |
| <b>RFSD</b> | <b>RF System Design</b>                                  | <b>5</b> |
| <b>SIM</b>  | <b>Simulation in der Ingenieurwissenschaft</b>           | <b>5</b> |
| <b>VAE</b>  | <b>Virtual Acoustic Environments</b>                     | <b>5</b> |
| <b>VER</b>  | <b>Virtuelle und erweiterte Realität</b>                 | <b>5</b> |

Modules of other faculties or universities:



| <b>Affiliation</b>                | <b>Module Name</b>                                    | <b>ECTS</b> |
|-----------------------------------|-------------------------------------------------------|-------------|
| TH Köln (Fakultät 10)             | Advanced Machine Learning                             | 6           |
| <b>TH Köln (Fakultät 10)</b>      | <b>Data Driven Modeling</b>                           | <b>6</b>    |
| <b>TH Köln (Fakultät 10)</b>      | <b>Data Science and Ethics</b>                        | <b>6</b>    |
| <b>TH Köln (Fakultät 10)</b>      | <b>Domain-Driven Design of Large Software Systems</b> | <b>6</b>    |
| <b>TH Köln (Fakultät 09)</b>      | <b>Modellierung von Energiesystemen</b>               | <b>5</b>    |
| TH Köln (Fakultät 10)             | Multivariate Statistik                                | 6           |
| Universität Köln                  | Quantum Information Theory                            | 6           |
| <b>Hochschule Bonn-Rhein-Sieg</b> | <b>Virtuelle Private Netze</b>                        | <b>6</b>    |

## 7.5 X - Fachübergreifende Kompetenzen und Soft Skills

In diesem Wahlbereich können Module zu außerfachlichen, nicht-technischen Themen belegt werden. Im Folgenden werden nur Module dargestellt, die regelmäßig angeboten werden. Es sind aber auch einmalig oder unregelmäßig angebotene Module in diesem Wahlbereich wählbar, beispielsweise Module, die von der Kompetenzwerkstatt angeboten werden. Die Anerkennung eines solchen, unten nicht aufgeführten Moduls für diesen Wahlbereich muss per E-Mail an die Studiengangleitung vor der Teilnahme geklärt werden.

You must select modules of 5 ECTS credit points in total out of this catalog.

Modules of the faculty:

| Module ID | Module Name                                                   | ECTS |
|-----------|---------------------------------------------------------------|------|
| ERMK      | Entrepreneurship, Gewerblicher Rechtsschutz, Market Knowledge | 5    |
| ETH       | Ethik                                                         | 5    |
| PHTM      | Philosophische Handlungstheorie Master                        | 5    |
| PLET      | Projektleitung                                                | 5    |
| PLSYP     | Projektleitung Systementwicklungs-Projekt                     | 5    |
| XGA       | Gremienarbeit                                                 | 0    |

Modules of other faculties or universities:

| Affiliation                  | Module Name                                                                      | ECTS |
|------------------------------|----------------------------------------------------------------------------------|------|
| TH Köln (Kompetenzwerkstatt) | Als Führungskraft begeistern - Die Basics im Leadership                          | 2    |
| TH Köln (Fakultät 10)        | Data Science and Ethics                                                          | 6    |
| TH Köln (Kompetenzwerkstatt) | Design Thinking                                                                  | 3    |
| TH Köln (Kompetenzwerkstatt) | Digitale Arbeitswelt                                                             | 5    |
| TH Köln (Kompetenzwerkstatt) | Entrepreneurship - Grundlagenveranstaltung                                       | 6    |
| TH Köln (Kompetenzwerkstatt) | Entwicklung von Geschäftsszenarios bei Existenzgründung                          | 6    |
| TH Köln (Kompetenzwerkstatt) | Intellectual Activism - feministische Verbindungen zwischen Forschung und Praxis | 3    |
| TH Köln (Kompetenzwerkstatt) | Interkulturelle Teamarbeit - Vielfalt als Erfolgsfaktor                          | 3    |
| TH Köln (Kompetenzwerkstatt) | Kommunikative Kompetenz in Führungssituationen                                   | 2    |
| TH Köln (Kompetenzwerkstatt) | Konflikte verstehen und effektiv lösen                                           | 2    |
| TH Köln (Kompetenzwerkstatt) | Konfliktlösungs- und Verhandlungstechniken                                       | 6    |
| TH Köln (Fakultät 10)        | Leadership Principles and Strategic Management                                   | 6    |
| TH Köln (Kompetenzwerkstatt) | Persönliche Karriereentscheidungen mit dem Entscheidungsnavi                     | 1    |
| TH Köln (Kompetenzwerkstatt) | Praxisprojekt: Komplexe Herausforderungen der digitalen Arbeitswelt              | 6    |
| TH Köln (Kompetenzwerkstatt) | Produktentwicklungsmethoden                                                      | 6    |
| TH Köln (Fakultät 10)        | Projektmanagement (deutsch)                                                      | 6    |
| TH Köln (Fakultät 10)        | Projektmanagement (englisch)                                                     | 6    |
| TH Köln (Kompetenzwerkstatt) | Rhetorik in der Gesprächsführung                                                 | 3    |
| TH Köln (Kompetenzwerkstatt) | Rhetorik in der Verhandlungstechnik                                              | 3    |
| TH Köln (Fakultät 04)        | Risk Management 1                                                                | 5    |
| TH Köln (Kompetenzwerkstatt) | Selbstlernmodul Moderation                                                       | 2    |
| TH Köln (Kompetenzwerkstatt) | Stärken stärken und Schwächen nutzen                                             | 1    |
| TH Köln (Fakultät 10)        | StartUp Bootcamp                                                                 | 5    |
| TH Köln (Fakultät 04)        | Steuern                                                                          | 6    |

| Affiliation                  | Module Name                                | ECTS |
|------------------------------|--------------------------------------------|------|
| TH Köln (Kompetenzwerkstatt) | Unternehmensführung im öffentlichen Sektor | 6    |

## 8. Specializations

There are no specializations in the study program.

Im Masterstudiengang Technische Informatik gibt es keine Studienrichtungen oder -schwerpunkte

## 9. Examination Types

The forms of examination referenced in the module descriptions are explained in more detail below. The explanations are taken from the examination regulations, §19ff. In case of deviations, the text of the examination regulations applies.

### **(Digital) Written exam**

Written, paper-based or digitally supported examination. Details are regulated in §19 of the examination regulations.

### **Oral examination**

Examination to be taken orally. Details are regulated in §21 of the examination regulations.

### **Oral contribution**

See §22, para. 5 of the examination regulations: An oral contribution (e.g. paper, presentation, negotiation, moderation) serves to determine whether students are capable of independently working on a practice-oriented task within a specified period of time using scientific and practical methods and presenting it in a technically appropriate manner by means of verbal communication. This also includes answering questions from the auditorium regarding the oral presentation. The duration of the oral presentation is determined by the examiner at the beginning of the semester. The facts relevant to the grading of the oral presentation are to be recorded in a protocol; students should also submit the written documents relating to the oral presentation for documentation purposes. Students must be notified of the grade no later than one week after the oral presentation.

### **Technical discussion**

See §22, Para. 8 of the examination regulations: A technical discussion serves to determine professional competence, understanding of complex technical contexts and the ability to solve problems analytically. Students and examiners have roughly equal speaking time in the technical discussion in order to enable a discursive technical exchange. One or more discussions are held with an examiner during the semester or in summary form. Students should present and explain practice-related technical tasks, problems or project plans from the degree program and explain the relevant technical background, theoretical concepts and methodological approaches for processing the tasks. Possible solutions, procedures and considerations for solving the problem must be discussed and justified. The facts relevant to the grading of the technical discussion must be recorded in a protocol.

### **Project work**

See §22, Para. 6 of the examination regulations: The project work is an examination that consists of independently working on a specific problem under supervision using scientific methodology and documenting the results. In addition to the quality of the answer to the question, the organizational and communicative quality of the implementation, such as slides, presentations, milestones, project plans, meeting minutes, etc., are also relevant for assessment.

### **Lab report**

See §22, para. 10 of the examination regulations: An internship report (e.g. experimental protocol) serves to determine whether students are capable of independently carrying out a practical laboratory task within a specified period of time, as well as documenting, evaluating and reflecting on the process and results in writing. Preparatory homework may be required before the actual experiment is carried out. Technical discussions may take place during or after the experiment. Internship reports can also be admitted to the examination in the form of group work. Students must be notified of the assessment of the practical placement report no later than six weeks after submission of the report.

### **Exercise lab**

See §22, para. 11 of the examination regulations: The examination form "practical training" tests the technical skills in the application of the theories and concepts learned in the lecture as well as practical skills, for example the use of development tools and technologies. For this purpose, several tasks are set during the semester, which are to be solved either alone or in group work, on site or as homework by a given deadline. The solutions to the tasks must be submitted by the students in (digital) written form. The exact criteria for passing the examination will be announced at the beginning of the corresponding course.

### **Exercise lab under examination conditions**

See §22, para. 11, sentence 5 of the examination regulations: A "practical training course under examination conditions" is a practical training course in which the tasks are to be completed within the time frame and under the independent conditions of an examination.

### **Term paper**

See §22, para. 3 of the examination regulations: A term paper (e.g. case study, research) serves to determine whether students are capable of independently completing a specialist task in written or electronic form using scientific and practical methods within a specified period of time. The topic and scope (e.g. number of pages of the text section) of the term paper are determined by the examiner at the beginning of the semester. A declaration of independence must be signed and submitted by the candidate. In addition, technical discussions may be held.

### **Learning portfolio**

A learning portfolio documents the student competence development process by means of presentations, essays, excerpts from internship reports, tables of contents of term papers, notes, to-do lists, research reports and other performance presentations and learning productions, summarized as so-called "artefacts". The learning portfolio only becomes an examination item in conjunction with the student's reflection (in writing, orally or in a video) on the use of these artifacts to achieve the learning objective previously made transparent by the examiner. During the creation of the learning portfolio, feedback on development steps and/or artifacts is given over the course of the semester. A revised form of the learning portfolio - in handwritten or electronic form - is submitted as the examination result following the feedback.

### **Single / Multiple choice**

See §20 of the examination regulations.

### **Access colloquium**

See §22, para. 12 of the examination regulations: An entrance colloquium serves to determine whether the students fulfill the specific requirements to be able to work independently and safely on a defined practical laboratory task using scientific and practical methods.

### **(Intermediate) Certificate**

See §22, para. 7 of the examination regulations: A test/intermediate test certifies that the student has completed a piece of coursework (e.g. draft) to the required standard. The scope of work to be completed and the required content and requirements can be found in the respective module description in the module handbook and in the assignment.

### **Open book preparation**

The open book assignment (OBA) is a short term paper and therefore an unsupervised written or electronic examination. It is characterized by the fact that, according to the examiner's declaration of aids, all aids are generally permitted. Special attention is drawn to the safeguarding of good scientific practice through proper citation etc. and the requirement of independence in the performance of each examination.

### **Thesis**

Bachelor's or Master's thesis as defined in the examination regulations §25ff: The Master's thesis is a written assignment. It should show that the student is capable of independently working on a topic from their subject area within a specified period of time, both in its technical details and in its interdisciplinary contexts, using scientific and practical methods. Interdisciplinary cooperation can also be taken into account in the final thesis.

### **Colloquium**

Colloquium for the Bachelor's or Master's thesis as defined in the examination regulations §29: The colloquium serves to determine whether the student is able to present the results of the Master's thesis, its technical and methodological foundations, interdisciplinary contexts and extracurricular references orally, to justify them independently and to assess their significance for practice.

## 10. Profile Module Matrix

The following section describes the extent to which the modules of the degree program support and develop the competencies and fields of action of the study program as well as certain study program criteria as defined by the University of Applied Science TH Köln.

| Abbr. | Module Name                                              | HF1 - Komplexe Rechner-, Kommun... | HF2 - Wissenschaftlich arbeiten... | HF3 - Fachliche Führungs- und P... | K.1 - Komplexe Systeme und Proz... | K.2 - Gesellschaftliche Vertret... | K.3 - Komplexe Aufgaben selbstä... | K.4 - Fachwissen erweitern und ... | K.5 - Aufkommende Technologien ... | K.6 - Probleme wissenschaftlich... | K.7 - Wissenschaftliche Ergebni... | K.8 - Situations- und sachgerec... | K.9 - Sich selbst organisieren | K.10 - Anerkannte Methoden für w... | K.11 - Sprachliche und interkult... | K.12 - Projekte organisieren und... | SK.1 - Global Citizenship | SK.2 - Internationalisierung | SK.3 - Interdisziplinarität | SK.4 - Transfer |
|-------|----------------------------------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|--------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|---------------------------|------------------------------|-----------------------------|-----------------|
| ACC   | Advanced Channel Coding                                  | ●                                  | ●                                  |                                    | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  |                                    |                                    |                                    | ●                              | ●                                   |                                     | ●                                   | ●                         | ●                            |                             |                 |
| AMC   | Advanced Multimedia Communications                       | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                              |                                     | ●                                   | ●                                   |                           | ●                            |                             |                 |
| AMS   | Special Aspects of Mobile Autonomous Systems             | ●                                  | ●                                  |                                    | ●                                  |                                    | ●                                  |                                    | ●                                  |                                    | ●                                  |                                    | ●                              |                                     |                                     |                                     |                           |                              | ●                           | ●               |
| ARP   | Alternative Rechnerarchitekturen und Programmiersprachen | ●                                  | ●                                  |                                    | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  |                                    | ●                              | ●                                   |                                     | ●                                   |                           |                              |                             |                 |
| AVT   | Audio- und Videotechnologien                             | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  |                                    | ●                              | ●                                   |                                     | ●                                   |                           |                              |                             |                 |
| CI    | Computational Intelligence                               | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  |                                    | ●                                  | ●                                  | ●                                  |                                    | ●                              |                                     |                                     | ●                                   |                           |                              |                             |                 |
| DLO   | Deep Learning und Objekterkennung                        | ●                                  | ●                                  |                                    | ●                                  | ●                                  | ●                                  | ●                                  |                                    | ●                                  |                                    |                                    | ●                              |                                     | ●                                   |                                     |                           |                              |                             |                 |
| DMC   | Digital Motion Control                                   | ●                                  | ●                                  |                                    | ●                                  | ●                                  |                                    |                                    | ●                                  | ●                                  | ●                                  | ●                                  | ●                              |                                     | ●                                   | ●                                   |                           |                              |                             |                 |
| DSP   | Digital Signal Processing                                | ●                                  | ●                                  |                                    | ●                                  | ●                                  | ●                                  |                                    | ●                                  |                                    |                                    |                                    | ●                              |                                     |                                     | ●                                   |                           | ●                            |                             |                 |
| ETH   | Ethik                                                    |                                    |                                    |                                    | ●                                  | ●                                  | ●                                  |                                    | ●                                  | ●                                  |                                    | ●                                  |                                |                                     | ●                                   | ●                                   | ●                         |                              | ●                           |                 |
| FP    | Forschungsprojekt                                        | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                              | ●                                   | ●                                   | ●                                   |                           | ●                            | ●                           | ●               |
| HIM   | Advanced Mathematics                                     |                                    |                                    |                                    |                                    | ●                                  | ●                                  |                                    |                                    |                                    |                                    |                                    | ●                              |                                     |                                     |                                     |                           | ●                            |                             |                 |
| IBD   | InnoBioDiv                                               |                                    |                                    |                                    | ●                                  | ●                                  | ●                                  |                                    | ●                                  | ●                                  | ●                                  |                                    |                                |                                     |                                     |                                     | ●                         | ●                            | ●                           | ●               |
| IIS   | Intelligent Information Systems                          | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  |                                    | ●                                  | ●                                  | ●                                  |                                    | ●                              |                                     |                                     | ●                                   |                           |                              |                             |                 |
| ITF   | IT-Forensik                                              | ●                                  |                                    |                                    | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  |                                    |                                    |                                    | ●                              | ●                                   |                                     | ●                                   |                           |                              |                             |                 |
| KOGA  | Kombinatorische Optimierung und Graphenalgorithmen       | ●                                  | ●                                  |                                    | ●                                  | ●                                  | ●                                  |                                    | ●                                  | ●                                  | ●                                  |                                    |                                |                                     |                                     | ●                                   |                           |                              |                             |                 |

| Abbr. | Module Name                                            | HF1 - Komplexe Rechner-, Kommun... | HF2 - Wissenschaftlich arbeiten... | HF3 - Fachliche Führungs- und P... | K.1 - Komplexe Systeme und Proz... | K.2 - Gesellschaftliche Vertret... | K.3 - Komplexe Aufgaben selbstä... | K.4 - Fachwissen erweitern und ... | K.5 - Aufkommende Technologien ... | K.6 - Probleme wissenschaftlich... | K.7 - Wissenschaftliche Ergebn... | K.8 - Situations- und sachgerec... | K.9 - Sich selbst organisieren | K.10 - Anerkannte Methoden für w... | K.11 - Sprachliche und interkult... | K.12 - Projekte organisieren und... | SK.1 - Global Citizenship | SK.2 - Internationalisierung | SK.3 - Interdisziplinarität | SK.4 - Transfer |
|-------|--------------------------------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|------------------------------------|-----------------------------------|------------------------------------|--------------------------------|-------------------------------------|-------------------------------------|-------------------------------------|---------------------------|------------------------------|-----------------------------|-----------------|
| KOLL  | Kolloquium zur Masterarbeit                            | ●                                  | ●                                  | ●                                  |                                    |                                    |                                    |                                    | ●                                  | ●                                  |                                   |                                    |                                |                                     |                                     |                                     |                           |                              |                             |                 |
| KRY   | Cryptography                                           | ●                                  | ●                                  |                                    | ●                                  | ●                                  |                                    |                                    | ●                                  |                                    |                                   |                                    | ●                              |                                     |                                     |                                     |                           | ●                            |                             |                 |
| LCSS  | Large and Cloud-based Software-Systems                 | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                 |                                    | ●                              |                                     |                                     | ●                                   |                           | ●                            |                             | ●               |
| MAA   | Masterarbeit                                           | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                 | ●                                  | ●                              | ●                                   | ●                                   | ●                                   |                           |                              | ●                           | ●               |
| MCI   | Mensch-Computer-Interaktion                            | ●                                  | ●                                  |                                    | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                 | ●                                  | ●                              | ●                                   | ●                                   | ●                                   | ●                         |                              | ●                           |                 |
| MLWR  | Maschinelles Lernen und wissenschaftliches Rechnen     |                                    |                                    |                                    |                                    |                                    | ●                                  |                                    | ●                                  |                                    |                                   | ●                                  | ●                              |                                     | ●                                   | ●                                   |                           |                              | ●                           | ●               |
| NGN   | Next Generation Networks                               | ●                                  | ●                                  |                                    | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  |                                   |                                    | ●                              |                                     |                                     |                                     |                           | ●                            |                             |                 |
| PAP   | Parallele Programmierung                               | ●                                  | ●                                  |                                    | ●                                  | ●                                  | ●                                  |                                    | ●                                  | ●                                  | ●                                 |                                    | ●                              |                                     |                                     |                                     |                           |                              |                             |                 |
| PHTM  | Philosophische Handlungstheorie Master                 |                                    |                                    |                                    |                                    |                                    |                                    |                                    |                                    |                                    |                                   |                                    |                                |                                     |                                     |                                     | ●                         |                              | ●                           |                 |
| PLET  | Projektleitung                                         | ●                                  | ●                                  | ●                                  |                                    |                                    | ●                                  | ●                                  |                                    | ●                                  |                                   | ●                                  |                                | ●                                   | ●                                   | ●                                   | ●                         |                              | ●                           |                 |
| PLSYP | Projektleitung Systementwicklungs-Projekt              |                                    |                                    | ●                                  |                                    | ●                                  |                                    | ●                                  |                                    |                                    |                                   |                                    |                                | ●                                   |                                     | ●                                   | ●                         |                              |                             |                 |
| QEKs  | Qualitätsgesteuerter Entwurf komplexer Softwaresysteme | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                 | ●                                  | ●                              | ●                                   | ●                                   | ●                                   |                           |                              |                             |                 |
| THI   | Theoretische Informatik                                | ●                                  | ●                                  |                                    | ●                                  | ●                                  |                                    |                                    | ●                                  | ●                                  | ●                                 |                                    |                                |                                     |                                     |                                     | ●                         |                              |                             |                 |
| VAE   | Virtual Acoustic Environments                          | ●                                  | ●                                  |                                    | ●                                  | ●                                  | ●                                  | ●                                  |                                    |                                    |                                   |                                    |                                | ●                                   |                                     | ●                                   |                           |                              | ●                           | ●               |
| VER   | Virtuelle und erweiterte Realität                      | ●                                  | ●                                  |                                    | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                  | ●                                 | ●                                  | ●                              |                                     | ●                                   | ●                                   |                           |                              |                             |                 |
| XIM   | Fachübergreifende Kompetenzen und Soft Skills          |                                    |                                    | ●                                  |                                    | ●                                  | ●                                  | ●                                  |                                    |                                    |                                   | ●                                  | ●                              |                                     | ●                                   |                                     |                           |                              |                             |                 |



## 11. Version History

The table below lists the different versions of the course offer. The versions are sorted in reverse chronological order with the currently valid version in the first row. The individual versions can be accessed via the link in the right-hand column on the right.

| Version | Date                | Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       | Link                 |
|---------|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------|
| 3.10    | 2024-12-06-08-45-55 | 1. Begutachtete Version für Reakkreditierung 2024<br>2. Neues Layout für sämtliche Modulhandbücher                                                                                                                                                                                                                                                                                                                                                                                            | <a href="#">Link</a> |
| 3.9     | 2024-07-06-12-00-00 | 1. Übernahme von "Visuelle und auditive Wahrnehmung" durch Prof. Reiter (vormals Prof. Kunz)<br>2. Übernahme von "Bildverarbeitung", "Projekt Bildverarbeitung / Mustererkennung", "Signaltheorie u. Angewandte Mathematik" durch Prof. Salmen (vormals Prof. Kunz)<br>3. Neues Modul "IT-Forensik" für Masterstudiengänge Technische Informatik, Medientechnologie und Elektrotechnik<br>4. Neues Modul "Ausgewählte Themen der Medientechnologie" und Lehrveranstaltung "Haptic Interfaces" | <a href="#">Link</a> |
| 3.8     | 2024-02-23-15-00-00 | 1. Generelle Überarbeitung des Layouts<br>2. Eingangstexte bei Wahlmodulkatalogen und Schwerpunkten überarbeitet und POs angeglichen<br>3. Lehrveranstaltung BWR (Kim) sowohl im Sommer- als auch Wintersemester.<br>4. Modellierung von Energiesystemen der Fakultät 09 als wählbares Modul im allgemeinen Wahlkatalog im Master Technische Informatik                                                                                                                                       | <a href="#">Link</a> |
| 3.7     | 2023-09-01-14-30-00 | 1. Neue(s) Modul und Lehrveranstaltung "InnoBioDiv" im Master Communication Systems and Engineering, Technische Informatik                                                                                                                                                                                                                                                                                                                                                                    | <a href="#">Link</a> |
| 3.6     | 2023-07-20-15-00-00 | 1. Neue Lehrveranstaltung "Projektleitung Systementwurfs-Praktikum" im Master Technische Informatik (anerkannt für XIM)<br>2. Geänderter Studienverlauf mit vermindertem Workload in Bachelor Technische Informatik                                                                                                                                                                                                                                                                           | <a href="#">Link</a> |
| 3.5     | 2023-03-14-18-00-00 | 1. LCSS aktualisiert                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | <a href="#">Link</a> |
| 3.4     | 2023-03-09-18-00-00 | 1. Wahlmodule in Bachelor Elektrotechnik angeglichen; Links zu Ilias in Würzberger-Lehrveranstaltungen                                                                                                                                                                                                                                                                                                                                                                                        | <a href="#">Link</a> |
| 3.3     | 2023-03-06-14-00-00 | 1. Neue Lehrveranstaltung "Software Engineering für die Automatisierungstechnik", Modulbeschreibungen für Kolloquium und Masterarbeit im Master Communications Systems and Networks, externes Modul "Steuern" für X1 in Master Technische Informatik                                                                                                                                                                                                                                          | <a href="#">Link</a> |
| 3.2     | 2023-02-24-20-00-00 | 1. Allgemeine Bereinigung von kaputten Links (http 404)                                                                                                                                                                                                                                                                                                                                                                                                                                       | <a href="#">Link</a> |
| 3.1     | 2023-02-16-15-13-00 | 1. Weitere Wahlmodule in Master Technische Informatik eingefügt (aus MaTIN2020_Aushang_FAQ.pdf)                                                                                                                                                                                                                                                                                                                                                                                               | <a href="#">Link</a> |
| 3.0     | 2023-02-12-17-30-00 | 1. Modul "Entrepreneurship, Gewerblicher Rechtsschutz, Market Knowledge" und Lehrveranstaltung "Gewerblicher Rechtsschutz" eingerichtet<br>2. Licht und Beleuchtungstechnik ins Wintersemester verschoben                                                                                                                                                                                                                                                                                     | <a href="#">Link</a> |

Impressum

Datenschutzhinweis

Haftungshinweis

Bei Fehlern, bitte Mitteilung an  
die  
[modulhandbuchredaktion@f07.th-koeln.de](mailto:modulhandbuchredaktion@f07.th-koeln.de)