Technology
Arts Sciences
TH Köln

Faculty of Information, Media and Electrical Engineering

Master Communication Systems and Networks 2024

Module Manual

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The most recent version of this handbook can be found here:
https://f07-studieninfo.web.th-koeln.de/mhb/current/en/MaCSN2024.html

1. Program Description

The ever-increasing interaction of hardware and software solutions and the networking of systems characterize the economic and technological developments in the computer industry and telecommunications sector. The Communication Systems and Networks degree program offers students the opportunity to understand and design the complex interrelationships of modern and future communication systems and services. A special feature of the course is the holistic view of communication systems from the system level to the network level, including the current security requirements for such systems. By choosing from two specialization profiles, Communication Systems and Networks and Security, students have the opportunity to acquire in-depth knowledge and skills in one of these areas, depending on their inclinations. The course is taught almost exclusively in English. It is therefore also aimed at international students with English language skills.

Occupational fields

The planning, development and customer-specific adaptation of new communication technology systems and networks are at the heart of professional activities. The generally strong demand for communication and information technology services in practically all sectors of the economy opens up numerous prospects in many industries. In addition to large companies in the mobile communications and telecommunications sector, there are manufacturers and suppliers of telecommunications equipment and facilities, network operators and broadcasters, manufacturers of consumer electronics equipment, machine and plant manufacturers, the automotive industry and its suppliers. should be mentioned. Work as a research assistant at scientific and public institutions and research facilities with the possibility of a doctorate is also envisaged.

Expectations of applicants

In addition to the formal admission requirements according to §3 of the examination regulations, students are expected to show a high degree of motivation, commitment, personal responsibility and resilience in the organization and implementation of their studies.

Study program

The Master's program is offered by the Institute of Communications Engineering of the Faculty of Information, Media and Electrical Engineering at the TH Köln in cooperation with the Department of Computer Science at the Bonn-Rhein-Sieg University of Applied Sciences in St. Augustin. It is characterized by a practice-oriented, professionally qualifying education. The modular structure of the course and the assessment of modules and courses according to the European Credit Transfer System (ECTS) facilitate international student exchange. The course is worth a total of 90 ECTS points. A large number of subjects are taught in English. The application-oriented Master's degree course in Communication Systems and Networks is designed for a standard period of study of three semesters, including the completion of the Master's thesis, and leads to a Master of Science degree. Through double degree agreements with the Universidad Polytécnico de Valéncia and the Universidad Polytécnico de Madrid, students have the opportunity to obtain a Master's degree from the TH Köln and a renowned Spanish university with little additional effort. The programs there are also largely offered in English.

Study requirements

- Bachelor's or Diplom degree in a computer science program, a mathematical-scientific or engineering program in the field of information and communication technology with at least 210 ECTS points and a final grade of better than 2.3.
- In the case of degrees with fewer than 210 ECTS points, the degree program can be accepted through additional achievements in the form of internships and/or courses.

Start of studies

The course usually begins in the summer semester. It is possible to start in the winter semester.

2. Graduate Profile

Graduates of the M. Sc. Communication Systems and Networks degree program are able to analyze, design and further develop highly complex communication systems and network technologies at an advanced scientific level. They assume responsibility in research, development, system integration and technological management -- both nationally and internationally. The course is aimed at qualified computer science and engineering graduates and clearly stands out from undergraduate courses due to its research-oriented, international and interdisciplinary focus.

The Master's degree course in Communication Systems and Networks is a scientifically sound, strongly application-oriented course in the field of information and communication technology. Unlike a Bachelor's degree, the CSN program focuses on the conceptual depth, cross-system responsibility and innovative design of future information and communication systems and networks.

Students acquire in-depth, interdisciplinary specialist knowledge in the areas of:

- Communication systems, network technologies and signal processing
- Information theory, information security and cryptography, embedded systems, AI-supported networks
- Distributed systems, IoT architectures, mobile networks, multimedia communication

The study program is characterized by

- complete delivery in English and international orientation,
- selectable profile specializations (“Communication Systems” or “Networks and Security”),
- close integration of research-based project work,
- double-degree programs with partner universities in Spain, and
- sound preparation for management positions and/or a doctorate.

Graduates of the degree program develop a profile specific to the Master's degree in the following areas:

- They design, implement and evaluate complex systems of modern communication and network technology, taking into account economic, ecological and ethical aspects.
- You are proficient in scientific methods at a high level and can work on research questions in a structured manner - also with a view to a later doctorate.
- Through projects such as the research project and the Master's thesis, they develop skills in scientific analysis, interdisciplinary teamwork and innovation.
- They are able to take on responsibility in dynamic, technology-driven environments such as mobile communications, IT infrastructure, IoT, broadcasting technology or cloud/edge computing.
- You have the intercultural and communication skills to work effectively in international teams and communicate complex issues convincingly.
- They are prepared to classify new technical developments, assess their relevance and independently acquire new skills - lifelong learning is a central component of their professional identity.

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 competencies 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 Studienverlaufsplan

Sem.	Abbr.	Module Name	Mandatory (PF) Elective Catalog (WB)	ECTS	Prüfungslast	Examination Types with Weights
1	HIM	Advanced Mathematics	PF	5	1	▪ final: (digital) written exam or oral examination [100%]
	BSN	Basics on Systems and Networks	PF	5	3	▪ accompanying: (intermediate) certificate and ▪ accompanying: (intermediate) certificate [ungraded] and ▪ final: (digital) written exam or oral examination [100%]
	PFM	Profile Module	WB	10	≤ 4	▪ selection dependend
	EL1	Electives Catalog 1	WB	5	≤ 2	▪ selection dependend
	PM	Project Management	PF	5	1	▪ accompanying: project work [ungraded]
2	PFM	Profile Module	WB	10	≤ 4	▪ selection dependend
	RP	Research Project	PF	10	1	▪ accompanying: oral contribution or project work [100%]
	EL1	Electives Catalog 1	WB	5	≤ 2	▪ selection dependend
	EL2	Electives Catalog 2	WB	5	≤ 2	▪ selection dependend
3	MAA	Masterarbeit	PF	27	1	▪ final: Thesis [100%]
	KOLL	Kolloquium zur Masterarbeit	PF	3	1	▪ final: Colloquium [100%]

5.2 Alternativer Studienverlaufsplan

Sem.	Abbr.	Module Name	Mandatory (PF) Elective Catalog (WB)	ECTS	Prüfungslast	Examination Types with Weights
1	PFM	Profile Module	WB	5	≤ 2	▪ selection dependend
	EL1	Electives Catalog 1	WB	5	≤ 2	▪ selection dependend
	HIM	Advanced Mathematics	PF	5	1	▪ final: (digital) written exam or oral examination [100%]
2	PFM	Profile Module	WB	10	≤ 4	▪ selection dependend
	EL1	Electives Catalog 1	WB	5	≤ 2	▪ selection dependend
3	BSN	Basics on Systems and Networks	PF	5	3	▪ accompanying: (intermediate) certificate and ▪ accompanying: (intermediate) certificate [ungraded] and ▪ final: (digital) written exam or oral examination [100%]
	PM	Project Management	PF	5	1	▪ accompanying: project work [ungraded]
	PFM	Profile Module	WB	5	≤ 2	▪ selection dependend
4	RP	Research Project	PF	10	1	▪ accompanying: oral contribution or project work [100%]
	EL2	Electives Catalog 2	WB	5	≤ 2	▪ selection dependend
5	MAA	Masterarbeit	PF	27	1	▪ final: Thesis [100%]
	KOLL	Kolloquium zur Masterarbeit	PF	3	1	▪ final: Colloquium [100%]

6. Modules

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

6.1 ACC - Advanced Channel Coding

Module ID	ACC_MaCSN2024
Module Name	Advanced Channel Coding
Type of Module	Elective Modules
Recognized Course	ACC - Advanced Channel Coding
ECTS credits	5
Language	englisch
Duration of Module	1 Semester
Recommended Semester	1-2
Frequency of Course	every summer term
Module Coordinator	Prof. Dr. Uwe Dettmar/Professor Fakultät IME
Lecturer(s)	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 programms, 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.

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) 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.

Teaching and Learning Methods	▪ Lecture / Exercises ▪ Lab
Examination Types with Weights	▪ accompanying: oral contribution or exercise lab under exam conditions [ungraded] and ▪ final: (digital) written exam or oral examination [100%]
Workload	150 Hours

Contact Hours	45 Hours ≙ 4 SWS
Self-Study	105 Hours
Recommended Prerequisites	▪ Modul HIM: Grundkenntnisse zur linearen Algebra, der Algebra in endlichen Zahlenkörpern, der Stochastik und der digitalen Kommunikationstechnik aus den vorangegangenen Bachelorstudiengängen. Da das Fach im ersten Fachsemster des Masters gewählt werden kann, können keine belastbaren Kenntnisse aus dem Fach HIM verpflichtend vorausgesetzt werden, auch wenn sie hilfreich wären. ▪ basics in linear algebra basics in stochastics good programming skills
Mandatory Prerequisites	▪ Lab requires attendance in the amount of: 2 Praktikumstermine und 1 Präsentation ▪ Participation in final examination only after successful participation in Lab
Recommended Literature	▪ R. E. Blahut. Algebraic Codes for Data Transmission. Cambridge University Press, Cambridge, 2003. ▪ S. Lin and D. J. Costello. Error Control Coding. ISBN 0-13-042672-5. Prentice-Hall, 2004 ▪ T. M. Cover and J. A. Thomas. Elements of Information Theory. Wiley, New Jersey, 2006 ▪ A. Neubauer. Kanalcodierung. Schlembach, Wilburgstetten, 2006. ▪ R. Roth. Introduction to Coding Theory. Cambridge, second edition, 2006 ▪ B. Sklar. Digital Communications. Prentice Hall PTR, Upper Saddle River, New Jersey, 2001
Use of the Module in Other Study Programs	▪ ACC in Master Communication Systems and Networks 2020 ▪ ACC in Master Technische Informatik 2020 ▪ ACC in Master Informatik und Systems-Engineering 2024
Permanent Links to Organization	ILU course page
Specifics and Notes	
Last Update	19.7.2025, 14:32:16

6.2 AMC - Advanced Multimedia Communications

Module ID	AMC_MaCSN2024
Module Name	Advanced Multimedia Communications
Type of Module	Elective Modules
Recognized Course	AMC - Advanced Multimedia Communications
ECTS credits	5
Language	englisch
Duration of Module	1 Semester
Recommended Semester	1-2
Frequency of Course	every winter term
Module Coordinator	Prof. Dr. Andreas Grebe/Professor Fakultät IME
Lecturer(s)	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, implemnt 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 multiservices networks, optionally based and on existing systems, and learn how to design, implementnt and anlysze 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-Exiperience (QoE), MOS Scale, Error Detection, Error Correction, FEC, Interleaving, Jitter Buffer.

> Students evaluate technologies and network architectures of multiservice networks; they analyse 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 wellcome.

Teaching and Learning Methods	▪ Lecture / Exercises ▪ Lab

Examination Types with Weights	▪ accompanying: exercise lab [ungraded] and ▪ final: (digital) written exam or oral examination [100%]
Workload	150 Hours
Contact Hours	45 Hours ≙ 4 SWS
Self-Study	105 Hours
Recommended Prerequisites	▪ Modul 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). ▪ 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, publishg-subscribe patterns.
Mandatory Prerequisites	▪ Lab requires attendance in the amount of: 6 Meilensteintermine und Projektvorstellungen ▪ Participation in final examination only after successful participation in Lab
Recommended Literature	▪ J. Kurose, K. Ross: Computer Networking: A Top-Down Approach, Global Edition, Prentice Hall, 7th ed., 2016 ▪ A. S. Tanenbaum, D. J. Wetherall: Computer Networks, Pearson , 5th ed., 2013 ▪ W. Stallings: Foundations of Modern Networking, Pearson Education, 2016 ▪ H. W. Barz, G. A. Bassett: Multimedia Networks, John Wiley & Sons, 2016 ▪ T. Szigeti, C. Hattingh, R. Barton, B. Kenneth: End-to-End QoS Network Design: Quality of Service for Rich-Media & Cloud Networks (2nd Edition) End-to-End QoS Network Design: Quality of Service for Rich-Media & Cloud Networks, Cisco Press, 2nd Ed. 2013 ▪ R. Steinmetz, K. Nahrstedt: „Multimedia Systems“, Springer 2004 ▪ R. Steinmetz, „Multimedia-Technologie“, Springer 2000
Use of the Module in Other Study Programs	▪ AMC in Master Communication Systems and Networks 2020 ▪ AMC in Master Technische Informatik 2020 ▪ AMC in Master Informatik und Systems-Engineering 2024
Specifics and Notes	
Last Update	19.7.2025, 14:32:16

6.3 BSN - Basics on Systems and Networks

Module ID	BSN_MaCSN2024
Module Name	Basics on Systems and Networks
Type of Module	Mandatory Module
Recognized Course	BSN - Basics on Systems and Networks
ECTS credits	5
Language	englisch
Duration of Module	1 Semester
Recommended Semester	1
Frequency of Course	every summer term
Module Coordinator	Prof. Dr. Rainer Kronberger/Professor Fakultät IME
Lecturer(s)	▪ Prof. Dr. Rainer Kronberger/Professor Fakultät IME ▪ Prof. Dr. Harald Elders-Boll/Professor Fakultät IME ▪ Prof. Dr. Uwe Dettmar/Professor Fakultät IME

Learning Outcome(s)

> Students learn the basics of communication systems and networks, by means of lectures, tutorials, exercises and practical laboratory experiments, so that they can later develop, design, analyze, measure and set up communication technology components, systems and networks.

Module Contents

Lecture

> Introduction to Digital Communication Systems and Networks
>
> Review of the Basics: Signals and Systems
>
> Review of the Basics: Probability Theory
>
> Representation of Bandpass Signals and Systems
>
> Signals, Noise, Electromagnetic Waves
>
> Wave Propagation
>
> Communication Components: Receiver and Transmitter
>
> Antennas
>
> Source Coding and Quantization
>
> Channel Coding and Cryptography
>
> Modulation
>
> OFDM
>
> Radio Standards and Mobile Communication Systems and Networks

Exercises / Lab

> Lab: Binary NRZ, IQ-Modulation and Demodulation
>
> Lab: Channel Coding and QPSK Modulation
>
> Lab: RF Signals

Teaching and Learning Methods	▪ Lecture ▪ Exercises / Lab

Examination Types with Weights	▪ accompanying: (intermediate) certificate and ▪ accompanying: (intermediate) certificate [ungraded] and ▪ final: (digital) written exam or oral examination [100%]
Workload	150 Hours
Contact Hours	45 Hours ≙ 4 SWS
Self-Study	105 Hours
Recommended Prerequisites	Basics in communications, electronics, information technologies
Mandatory Prerequisites	▪ Participation in final examination only after successful participation in Lecture ▪ Exercises / Lab requires attendance in the amount of: 3 Testattermine ▪ Participation in final examination only after successful participation in Exercises / Lab
Recommended Literature	▪ Tolga M. Duman, Fundamentals of Digital Communication Systems,Cambridge University Press, 2025 ▪ John Proakis and Masoud Salehi. Digital Communications. 5th. McGraw-Hill, 2007 ▪ Michael Rice. Digital Communications: A Discrete-Time Approach. Pearson Prentice Hall, 2009. ▪ James Kurose and Keith Ross. Computer Networking A Top Down Approach. 7th ed. Pearson, 2016. ▪ Andrew S. Tanenbaum, Nick Feamster, and David J. Wetherall. Computer Networks. 6th ed. Pearson, 2021. ▪ Ha H. Nguyen and Ed Shwedyk. A First Course in Digital Communications. Cambridge University Press, 2009. ▪ Upamanyu Madhow. Fundamentals of Digital Communication. Cambridge University Press, 2008.
Use of the Module in Other Study Programs	BSN in Master Communication Systems and Networks 2020
Permanent Links to Organization	Link for the learning platform
Specifics and Notes	
Last Update	19.7.2025, 14:32:16

6.4 DSP - Digital Signal Processing

Module ID	DSP_MaCSN2024
Module Name	Digital Signal Processing
Type of Module	Elective Modules
Recognized Course	DSP - Digital Signal Processing
ECTS credits	5
Language	englisch
Duration of Module	1 Semester
Recommended Semester	1-2
Frequency of Course	every winter term
Module Coordinator	Prof. Dr. Harald Elders-Boll/Professor Fakultät IME
Lecturer(s)	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.

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 Probablity 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
Sudents can use the FFT to implement an FIR system

Lab

Review of Probablity 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

Abilty to trade-off different methods for digital coding of speech and audio signals

Teaching and Learning Methods	▪ Lecture / Exercises ▪ Lab
Examination Types with Weights	▪ accompanying: (intermediate) certificate [ungraded] and ▪ final: oral examination [100%]
Workload	150 Hours
Contact Hours	45 Hours ≙ 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. Schafer. 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 Technische Informatik 2020 ▪ DSP in Master Informatik und Systems-Engineering 2024
Specifics and Notes	
Last Update	19.7.2025, 14:32:16

6.5 ESD - Embedded Systems Design

Module ID	ESD_MaCSN2024
Module Name	Embedded Systems Design
Type of Module	Elective Modules
Recognized Course	ESD - Embedded Systems Design
ECTS credits	5
Language	deutsch, englisch bei Bedarf
Duration of Module	1 Semester
Recommended Semester	1-2
Frequency of Course	every summer term
Module Coordinator	Prof. Dr. Markus Cremer/Professor Fakultät IME
Lecturer(s)	Prof. Dr. Markus Cremer/Professor Fakultät IME

Learning Outcome(s)

> Die Studierenden können die Machbarkeit der Entwicklung einer Produktidee im Bereich der Embedded Systems in Bezug auf praktische Realisierbarkeit, Aufwand, Zeit und Kosten und mit vorausschauendem Blick auf den gesamten Entwicklungsprozess sicher beurteilen. Hierzu setzen sie, ausgehend von einer eigenen Produktidee, Methoden und Hilfsmittel (z.B. Software-Tools, Konzepte, Best-Practices, v.a. auch Hardwareentwicklung) eines typischen industriellen Entwicklungsprozesses für Embedded Systems eigenständig praktisch um. Später sind die Studierenden in der Lage, diesen gesamten Entwicklungsprozess in der Industrie oder in Forschungsprojekten autonom zu bewerten und umzusetzen.

Module Contents

Lecture / Exercises

> The exact content will not be determined until the summer semester 2025.

Project

Teaching and Learning Methods	▪ Lecture / Exercises ▪ Project
Examination Types with Weights	▪ accompanying: project work [100%]
Workload	150 Hours
Contact Hours	45 Hours ≙ 4 SWS
Self-Study	105 Hours
Recommended Prerequisites	Basic knowledge of electrical engineering (simple analog and digital circuits) Basic knowledge of embedded systems (basics of microcontrollers incl. implementation of firmware)
Mandatory Prerequisites	

Recommended Literature	▪ Murti, K. (2022). Design Principles for Embedded Systems. Springer Singapore. https://doi.org/10.1007/978-981-16-3293-8 ▪ Schmidt, R., Hauschild, D., & Kluge, I. (2024). Elektronik Design: Theorie und Praxis. Elektronik Design: Theorie Und Praxis. https://doi.org/10.1007/978-3-662-68676-8 ▪ Ünsalan, C., Gürhan, H. D., & Yücel, M. E. (2022). Embedded system design with ARM Cortex-M microcontrollers: Applications with C, C++ and MicroPython. Embedded System Design with ARM Cortex-M Microcontrollers: Applications with C, C++ and MicroPython, 1–569. https://doi.org/10.1007/978-3-030-88439-0 ▪ Morshed, B. I. (2021). Embedded systems - A hardware-software co-design approach: Unleash the power of arduino! In Embedded Systems - A Hardware-Software Co-Design Approach: Unleash the Power of Arduino! Springer International Publishing. https://doi.org/10.1007/978-3-030-66808-2 ▪ Marwedel, P. (2021). Embedded System Design. https://doi.org/10.1007/978-3-030-60910-8 ▪ Lienig, J., & Scheible, J. (2020). Fundamentals of Layout Design for Electronic Circuits. Fundamentals of Layout Design for Electronic Circuits. https://doi.org/10.1007/978-3-030-39284-0
Use of the Module in Other Study Programs	▪ ESD in Master Elektrotechnik und Informationstechnik 2024 ▪ ESD in Master Medientechnologie 2024 ▪ ESD in Master Informatik und Systems-Engineering 2024
Permanent Links to Organization	ILU course
Specifics and Notes	
Last Update	19.7.2025, 14:32:16

6.6 HIM - Advanced Mathematics

Module ID	HIM_MaCSN2024
Module Name	Advanced Mathematics
Type of Module	Mandatory Module
Recognized Course	HIM - Advanced Mathematics
ECTS credits	5
Language	deutsch und englisch
Duration of Module	1 Semester
Recommended Semester	1
Frequency of Course	every term
Module Coordinator	Prof. Dr. Heiko Knospe/Professor Fakultät IME
Lecturer(s)	▪ Prof. Dr. Heiko Knospe/Professor Fakultät IME ▪ Prof. Dr. Hubert Randerath/Professor Fakultät IME ▪ Prof. Dr. Beate Rhein/Professor Fakultät IME

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 Vetoranalysis, Statistik und Optimierung) werden in mehreren Moduln des Studiengangs benötigt. Mathematische Methoden sind essentiell für Ingenieure, die wissenschaftlch arbeiten und wissenschaftliche Erkenntnisse anwenden und erweitern (HF2).

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

> -

Teaching and Learning Methods	Lecture / Exercises
Examination Types with Weights	▪ final: (digital) written exam or oral examination [100%]
Workload	150 Hours
Contact Hours	34 Hours ≙ 3 SWS
Self-Study	116 Hours
Recommended Prerequisites	Differential and integral calculus and linear algebra (Bachelor-level mathematics)
Mandatory Prerequisites	
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
Use of the Module in Other Study Programs	▪ HIM in Master Communication Systems and Networks 2020 ▪ HIM in Master Elektrotechnik 2020 ▪ HIM in Master Elektrotechnik und Informationstechnik 2024 ▪ HIM in Master Technische Informatik 2020 ▪ HIM in Master Informatik und Systems-Engineering 2024
Specifics and Notes	
Last Update	19.7.2025, 14:32:16

6.7 IBD - InnoBioDiv

Module ID	IBD_MaCSN2024
Module Name	InnoBioDiv
Type of Module	Elective Modules
Recognized Course	IBD - InnoBioDiv student projects
ECTS credits	5
Language	englisch
Duration of Module	0.5 Semester
Recommended Semester	1-2
Frequency of Course	every term
Module Coordinator	Prof. Dr. Uwe Dettmar/Professor Fakultät IME
Lecturer(s)	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 differentMINT 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.

Teaching and Learning Methods	▪ Seminar ▪ Project
Examination Types with Weights	▪ accompanying: project work [100%]
Workload	150 Hours
Contact Hours	23 Hours ≙ 2 SWS
Self-Study	127 Hours

Recommended Prerequisites	- fluent English since working intercultural and interdisciplinary teams. - basic knowledge in IoT and robotics desireable - ability to work in a team - basic knowledge in plant bilology are not mandatory
Mandatory Prerequisites	▪ Seminar requires attendance in the amount of: 8 Stunden ▪ Project requires attendance in the amount of: 5 meetings for project discussions
Recommended Literature	▪ https://farm.bot/ ▪ 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 ▪ Agrawal, D. P. (2017). Embedded Sensor Systems. Springer. ▪ 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 ▪ L. Urry, S. Wassermann: Campbell Biology AP Edition (12th Edition), Pearsson, ISBN-13: 978-0-13-648687-9 ▪ Taiz, L., Møller, I. M., Murphy, A., & Zeiger, E. (2022). Plant Physiology and Development. Oxford University Press.
Use of the Module in Other Study Programs	▪ IBD in Master Communication Systems and Networks 2020 ▪ IBD in Master Elektrotechnik und Informationstechnik 2024 ▪ IBD in Master Medientechnologie 2024 ▪ IBD in Master Technische Informatik 2020 ▪ IBD in Master Informatik und Systems-Engineering 2024
Permanent Links to Organization	Course description in the learning platform
Specifics and Notes	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
Last Update	19.7.2025, 14:32:16

6.8 ITF - IT-Forensik

Module ID	ITF_MaCSN2024
Module Name	IT-Forensik
Type of Module	Elective Modules
Recognized Course	ITF - IT forensics
ECTS credits	5
Language	deutsch, englisch bei Bedarf
Duration of Module	1 Semester
Recommended Semester	1-2
Frequency of Course	every winter term
Module Coordinator	Studiengangsleiter(in) Master Technische Informatik / Informatik und Systems-Engineering
Lecturer(s)	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.

Teaching and Learning Methods	▪ Lecture / Exercises ▪ Project
Examination Types with Weights	▪ accompanying: project work [100%]
Workload	150 Hours
Contact Hours	45 Hours ≙ 4 SWS
Self-Study	105 Hours

Recommended Prerequisites	
Mandatory Prerequisites	
Recommended Literature	
Use of the Module in Other Study Programs	▪ ITF in Master Communication Systems and Networks 2020 ▪ 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 Technische Informatik 2020 ▪ ITF in Master Informatik und Systems-Engineering 2024
Specifics and Notes	
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6.9 KOLL - Kolloquium zur Masterarbeit

Module ID	KOLL_MaCSN2024
Module Name	Kolloquium zur Masterarbeit
Type of Module	Mandatory Module
Recognized Course	MAKOLL - Colloquium
ECTS credits	3
Language	deutsch, englisch bei Bedarf
Duration of Module	1 Semester
Recommended Semester	3
Frequency of Course	every term
Module Coordinator	Studiengangsleiter(in) Master Technische Informatik / Informatik und Systems-Engineering
Lecturer(s)	verschiedene Dozenten*innen / diverse lecturers

Learning Outcome(s)

> - Darstellung von Forschungsergebnissen in einer Präsentation in vorgegebenem engen zeitlichen Rahmen
> - Fachliche und außerfachliche Bezüge der eigenen Arbeit darstellen und begründen
> - Eigene Lösungswege und gewonnene Erkenntnisse darstellen und diskutieren

Module Contents

Colloquium

> 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

Teaching and Learning Methods	Colloquium
Examination Types with Weights	▪ final: Colloquium [100%]
Workload	90 Hours
Contact Hours	0 Hours ≙ 0 SWS
Self-Study	90 Hours
Recommended Prerequisites	
Mandatory Prerequisites	▪ Module MAA: Die Masterarbeit muss abgeschlossen sein, damit sie im Kolloquium ganzheitlich und abschließend präsentiert werden kann. ▪ See exam regulations §29, paragraph 2
Recommended Literature	
Use of the Module in Other Study Programs	▪ KOLL in Master Communication Systems and Networks 2020 ▪ KOLL in Master Elektrotechnik 2020 ▪ KOLL in Master Elektrotechnik und Informationstechnik 2024 ▪ KOLL in Master Medientechnologie 2020 ▪ KOLL in Master Medientechnologie 2024 ▪ KOLL in Master Technische Informatik 2020 ▪ KOLL in Master Informatik und Systems-Engineering 2024
Specifics and Notes	See also examination regulations §29.
Last Update	19.7.2025, 14:32:16

6.10 KRY - Cryptography

Module ID	KRY_MaCSN2024
Module Name	Cryptography
Type of Module	Elective Modules
Recognized Course	KRY - Cryptography
ECTS credits	5
Language	englisch
Duration of Module	1 Semester
Recommended Semester	1-2
Frequency of Course	every summer term
Module Coordinator	Prof. Dr. Heiko Knospe/Professor Fakultät IME
Lecturer(s)	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 Implemenierung 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 properies 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	▪ accompanying: exercise lab [ungraded] and ▪ final: (digital) written exam or oral examination [100%]
Workload	150 Hours
Contact Hours	45 Hours ≙ 4 SWS
Self-Study	105 Hours
Recommended Prerequisites	Mathematics (Bachelor level) and programming skills.
Mandatory Prerequisites	▪ Lab requires attendance in the amount of: 3 Termine ▪ Participation in final examination only after successful participation in Lab
Recommended Literature	▪ M. Bellare, P. Rogaway, Introduction to Modern Cryptography, UCSD CSE ▪ H. Delfs, H. Knebl, Introduction to Cryptography, Springer ▪ S. Goldwasser, M. Bellare, Lecture Notes on Cryptography, MIT ▪ J. Hoffstein, J. Pipher, J.H. Silverman, An Introduction to Mathematical Cryptography, Springer ▪ J. Katz, Y. Lindell, Introduction to Modern Cryptography, CRC Press ▪ H. Knospe, A Course in Cryptography, American Mathematical Society ▪ C. Paar, J. Pelz, Understanding Cryptography. Springer ▪ N.P. Smart, Cryptography Made Simple, Springer ▪ K. H. Rosen, Discrete Mathematics and its Applications, McGraw-Hill ▪ V. Shoup, A Computational Introduction to Number Theory and Algebra, Cambridge University Press
Use of the Module in Other Study Programs	▪ KRY in Master Communication Systems and Networks 2020 ▪ KRY in Master Technische Informatik 2020 ▪ KRY in Master Informatik und Systems-Engineering 2024
Specifics and Notes	
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6.11 KVS - Communication in Distributed Systems and Networks

Module ID	KVS_MaCSN2024
Module Name	Communication in Distributed Systems and Networks
Type of Module	Elective Modules
Recognized Course	KVS - Communication in Distributed Systems and Networks
ECTS credits	5
Language	
Duration of Module	1 Semester
Recommended Semester	1-2
Frequency of Course	every summer term
Module Coordinator	Prof. Dr. Michael Radermacher/Professor Hochschule Bonn-Rhein-Sieg
Lecturer(s)	Prof. Dr. Michael Radermacher/Professor Hochschule Bonn-Rhein-Sieg

Learning Outcome(s)

> Die Studierenden lernen grundlegende theoretische Prinzipien der Kommunikationsnetze kennen. Durch Lektüre und anschließende Diskussion zentraler Publikationen, die kritische Auseinandersetzung mit aktuellen Forschungsarbeiten im Bereich der Kommunikationsnetze und die erfolgreiche Bearbeitung einer semesterbegleitenden Aufgabe können sie zukünftige Entwicklungen im Bereich der Kommunikationsnetze bewerten und neue Algorithmen und Protokollabläufe beurteilen.

Module Contents

Seminar-style Teaching

> Students learn about selected current research topics in communication technology. These include, for example, current developments in technologies, protocols and security mechanisms.

> Professional competence: Students learn about current research topics in the field of communication networks and can evaluate future developments.

> Methodological competence: Students learn to critically examine current research work in the field of communication networks by reading and then discussing key publications. They develop their analytical skills to evaluate new algorithms and protocol sequences. Students gain their first experience of independent research work in this field.

> Social skills: Students actively discuss developments in the field of communication networks during the course.

> Interdisciplinary competence: Students evaluate the reproducibility of other researchers' research results through their own work.

Teaching and Learning Methods	Seminar-style Teaching
Examination Types with Weights	▪ accompanying: project work [ungraded] and ▪ final: oral examination or (digital) written exam [100%]
Workload	150 Hours
Contact Hours	23 Hours ≙ 2 SWS
Self-Study	127 Hours
Recommended Prerequisites	Basic knowledge of object-oriented programming (e.g. in C++) Good knowledge of computer networks Ability to read and understand English texts
Mandatory Prerequisites	▪ Seminar-style Teaching requires attendance in the amount of: 4 Termine ▪ Participation in final examination only after successful participation in Seminar-style Teaching

Recommended Literature	▪ Morgner, P.; Mattejat, S.; Benenson, Z.: All Your Bulbs Are Belong to Us Investigating the current state of security in connected lighting systems. ▪ Pohl, J.; Noack, A. : Universal Radio Hacker: A Suite for Analyzing and Attacking Stateful Wireless Protocols ▪ Rademacher, M.; Linka, H.; Horstmann, T.; Henze , M. : Path Loss in Urban LoRa Networks ▪ Bosshart, P. et.al. : P4 : Programming Protocol-Independent Packet Processors ▪ Boley, A.C.; Byers, M. : Satellite mega-constellations create risks in Low Earth Orbit, the atmosphere and on Earth ▪ Clark, D. : The design philosophy of the DARPA internet protocols ▪ Lauridsen, M. et.al. : Coverage and Capacity Analysis of LTE-M and NB-IoT in a Rural Area ▪ Liu, G.; Huang, Y.; Chen, Z; Liu, L.; Wang, Q.; Li,N. : 5G Deployment
Use of the Module in Other Study Programs	KVS in Master Communication Systems and Networks 2020
Permanent Links to Organization	Module description
Specifics and Notes	
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6.12 LCSS - Large and Cloud-based Software-Systems

Module ID	LCSS_MaCSN2024
Module Name	Large and Cloud-based Software-Systems
Type of Module	Elective Modules
Recognized Course	LCSS - Large and Cloud-based Software-Systems
ECTS credits	5
Language	englisch
Duration of Module	1 Semester
Recommended Semester	1-2
Frequency of Course	every summer term
Module Coordinator	Prof. Dr. René Wörzberger/Professor Fakultät IME
Lecturer(s)	Prof. Dr. René Wörzberger/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 deci-sions,
- 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 pro-jects 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. consisten 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.

Teaching and Learning Methods	▪ Lecture / Exercises ▪ Project
Examination Types with Weights	▪ accompanying: project work [60%] and ▪ final: (digital) written exam or oral examination [40%]
Workload	150 Hours
Contact Hours	45 Hours ≙ 4 SWS
Self-Study	105 Hours
Recommended Prerequisites	- advanced programming skills - basic knowledge of web technologies - basic knowledge of databases - basic knowledge in software architectures - basic knowledge of Unified Modeling Language (UML)
Mandatory Prerequisites	Project requires attendance in the amount of: 4 Termine
Recommended Literature	▪ Lecture Notes Large and Cloud-based Software Systems ▪ H. Adkins et al.: Building Secure and Reliable Systems, O'Reilly Media, 2020 ▪ I. Gregorik: High Performance Browser Networking, O'Reilly Media, 2013 ▪ M. Kleppmann: Designing Data-Intensive Applications, O'Reilly Media, 2017
Use of the Module in Other Study Programs	▪ LCSS in Master Medientechnologie 2024 ▪ LCSS in Master Technische Informatik 2020 ▪ LCSS in Master Informatik und Systems-Engineering 2024
Permanent Links to Organization	llu course
Specifics and Notes	

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6.13 MAA - Masterarbeit

Module ID	MAA_MaCSN2024
Module Name	Masterarbeit
Type of Module	Mandatory Module
Recognized Course	MAA - Master thesis
ECTS credits	27
Language	deutsch, englisch bei Bedarf
Duration of Module	1 Semester
Recommended Semester	3
Frequency of Course	every term
Module Coordinator	Studiengangsleiter(in) Master Technische Informatik / Informatik und Systems-Engineering
Lecturer(s)	verschiedene Dozenten*innen / diverse lecturers

Learning Outcome(s)

> Das Modul vermittelt folgende Kenntnisse und Fertigkeiten:
> - Komplexe Aufgabenstellungen beurteilen
> - Selbständiges 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 addressiert 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.

Teaching and Learning Methods	Thesis
Examination Types with Weights	▪ final: Thesis [100%]
Workload	810 Hours
Contact Hours	0 Hours ≙ 0 SWS
Self-Study	810 Hours
Recommended Prerequisites	See examination regulations §26
Mandatory Prerequisites	see exam regulations §26 paragraph 1

Recommended Literature	
Use of the Module in Other Study Programs	▪ MAA in Master Communication Systems and Networks 2020 ▪ MAA in Master Elektrotechnik 2020 ▪ MAA in Master Elektrotechnik und Informationstechnik 2024 ▪ MAA in Master Medientechnologie 2020 ▪ MAA in Master Medientechnologie 2024 ▪ MAA in Master Technische Informatik 2020 ▪ MAA in Master Informatik und Systems-Engineering 2024
Specifics and Notes	See also examination regulations §24ff. Contact a professor of the faculty early on for the initial supervision of the thesis.
Last Update	19.7.2025, 14:32:16

6.14 MLWR - Maschinelles Lernen und wissenschaftliches Rechnen

Module ID	MLWR_MaCSN2024
Module Name	Maschinelles Lernen und wissenschaftliches Rechnen
Type of Module	Elective Modules
Recognized Course	MLWR - Machine Learning and Scientific Computing
ECTS credits	5
Language	deutsch
Duration of Module	1 Semester
Recommended Semester	1-2
Frequency of Course	every summer term
Module Coordinator	Prof. Dr. Beate Rhein/Professor Fakultät IME
Lecturer(s)	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	▪ accompanying: project work [20%] and ▪ final: oral examination [80%]
Workload	150 Hours
Contact Hours	45 Hours ≙ 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. Alammar: 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 Elektrotechnik 2020 ▪ MLWR in Master Elektrotechnik und Informationstechnik 2024 ▪ MLWR in Master Medientechnologie 2024 ▪ MLWR in Master Technische Informatik 2020 ▪ MLWR in Master Informatik und Systems-Engineering 2024
Specifics and Notes	
Last Update	19.7.2025, 14:32:16

6.15 NGN - Next Generation Networks

Module ID	NGN_MaCSN2024
Module Name	Next Generation Networks
Type of Module	Elective Modules
Recognized Course	NGN - Next Generation Networks
ECTS credits	5
Language	englisch
Duration of Module	1 Semester
Recommended Semester	1-2
Frequency of Course	every summer term
Module Coordinator	Prof. Dr. Andreas Grebe/Professor Fakultät IME
Lecturer(s)	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 serivces in lectures and exercises. In a small team and organized as semester project, students develop their own NGN service solution, optionally based and on existing systems, and learn how to design, implementnt and anlysze their own service solution.
> What for?
> To be able to design, analyze, select, use and apply actual and future network servces, based on All-IP networks for enterprise networks, telecommunication networks and mobile networks.

Module Contents

Lecture / Exercises

> Achive basic understanding and implementation knowledge on Next Generation Network (NGN) defintion 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 encaplsulation, 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 anlaysis 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 wellcome.

Teaching and Learning Methods	▪ Lecture / Exercises ▪ Lab

Examination Types with Weights	▪ accompanying: exercise lab [ungraded] and ▪ final: (digital) written exam or oral examination [100%]
Workload	150 Hours
Contact Hours	45 Hours ≙ 4 SWS
Self-Study	105 Hours
Recommended Prerequisites	▪ Modul BSN: Bachelor Level Networking Knowledge and Skills like teached 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). ▪ 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, publishg-subscribe patterns.
Mandatory Prerequisites	▪ Lab requires attendance in the amount of: 6 Meilensteintermine und Projektvorstellungen ▪ Participation in final examination only after successful participation in Lab
Recommended Literature	▪ J. Kurose, K. Ross: Computer Networking: A Top-Down Approach, Global Edition, Prentice Hall, 7th ed., 2016 ▪ A. S. Tanenbaum, D. J. Wetherall: Computer Networks, Pearson , 5th ed., 2013 ▪ U.Trick, F. Weber: SIP und Telekommunikationsnetze: Next Generation Networks und Multimedia over IP – konkret, De Gruyter Oldenbourg Verlag, 4. Auflage 2015 ▪ J. F. Durkin: Voice-enabling the Data Network,Cisco Press 2010 ▪ G. Camarillo, M.A. García-Martín: The 3G IP Multimedia Subsystem (IMS), John Wiley Verlag, 2006 ▪ W. Stallings: Foundations of Modern Networking, Pearson Education, 2016 ▪ J. Doherty: SDN and NFV Simplified, Pearson Education, 2016 ▪ J. Edelman: Network Programmability and Automation, O'Reilly 2018 ▪ J. van Meggelen, R. Bryant, L. Madsen: Asterisk: The Definitive Guide: Open Source Telephony for the Enterprise, O'Reilly Media, 5th Ed. 2019
Use of the Module in Other Study Programs	▪ NGN in Master Communication Systems and Networks 2020 ▪ NGN in Master Technische Informatik 2020 ▪ NGN in Master Informatik und Systems-Engineering 2024
Specifics and Notes	
Last Update	19.7.2025, 14:32:16

6.16 PM - Project Management

Module ID	PM_MaCSN2024
Module Name	Project Management
Type of Module	Mandatory Module
Recognized Course	PM - Project Management
ECTS credits	5
Language	deutsch, englisch bei Bedarf
Duration of Module	1 Semester
Recommended Semester	1
Frequency of Course	every term
Module Coordinator	Prof. Dr. Uwe Dettmar/Professor Fakultät IME
Lecturer(s)	Said Erkan/Lehrbeauftragter

Learning Outcome(s)

> What? Learn how to create a project plan as part of their study
>
> How? by applying project management concepts and processes to their "real-life" projects allowing them to generate immediate results that are usable in their future business situation. It acquires hands-on experience in applying new concepts and techniques in a project team environment and gain the confidence to take this forward to their environment.
>
> Why? To be prepared managing projects during their work life of proficiency.

Module Contents

Seminar

> Students learn basic PM methods, PM organizations, PM Tools
> Project Management Fundamentals, and Project Initiation based on the PMI curriculum by presentations and team work, and source browsing.

Project

> Practice project management concepts and processes to their "real-life" projects in classroom and team work and One by One sessions. Learn about planning, execution, controlling, and closing a project

Teaching and Learning Methods	▪ Seminar ▪ Project
Examination Types with Weights	▪ accompanying: project work [ungraded]
Workload	150 Hours
Contact Hours	23 Hours ≙ 2 SWS
Self-Study	127 Hours
Recommended Prerequisites	Some basic knowledge on project management
Mandatory Prerequisites	
Recommended Literature	▪ PMP Handbook ▪ www.scrumalliance.org

Use of the Module in Other Study Programs	PM in Master Communication Systems and Networks 2020
Specifics and Notes	
Last Update	19.7.2025, 14:32:16

6.17 QC - Quantum Computing

Module ID	QC_MaCSN2024
Module Name	Quantum Computing
Type of Module	Elective Modules
Recognized Course	QC - Quantum Computing
ECTS credits	5
Language	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)	▪ Prof. Dr. Pascal Cerfontaine/Professor Fakultät IME ▪ Prof. Dr. Heiko Knospe/Professor Fakultät IME

Learning Outcome(s)

> Was: Die Studierenden lernen die Grundlagen des Quantum Computing kennen. Es werden die mathematischen Grundlagen des Quantum Computing und Kenntnisse über Quanten-Schaltkreise und wichtige Quanten-Algorithmen vermittelt (HF 1).
> Womit: Der Dozent/die Dozentin vermittelt Wissen und Basisfertigkeiten in der Vorlesung. In der Übung bearbeiten die Studierenden unter Anleitung Aufgaben und entwickeln Quantenalgorithmen (HF 1).
> Wozu: Quantencomputer können mit Hilfe von verschränkten Qubits eine große Zahl von Eingangswerten gleichzeitig verarbeiten und bestimmte schwere Probleme lösen (HF 2).

Module Contents

Lecture / Exercises

> - Fundamental concepts
> - Single Quantum Bits
> - Bloch Sphere
> - Quantum Key Distribution
> - Hilbert spaces
> - Bra-Ket notation
> - Inner product, Outer product, Tensor product
> - Hermitian and unitary operators
> - Multiple Qubit Systems
> - Entangled states
> - Measurement
> - Quantum Gates and Circuits
> - Realizing unitary transformations as Quantum Circuits
> - Deutsch and Deutsch-Josza algorithms
> - Discrete Fourier Transform and Quantum Fourier Transform
> - Quantum Algorithms: Shor, Grover, HHL (optional)
> - Quantum complexity classes
> - Quantum Error Correction (optional)

> Practical quantum computing and coding using the Qiskit SDK.

Teaching and Learning Methods	Lecture / Exercises
Examination Types with Weights	▪ final: (digital) written exam or oral examination [100%]
Workload	150 Hours
Contact Hours	34 Hours ≙ 3 SWS

Self-Study	116 Hours
Recommended Prerequisites	
Mandatory Prerequisites	
Recommended Literature	▪ M.A. Nielsen, I.L. Chuang, Quantum Computation and Quantum Information, Cambridge University Press. ▪ E. Rieffel, W. Polak, Quantum Computing, MIT Press. ▪ B. Zygelman, A First Introduction to Quantum Computing and Information, Springer. ▪ H.Y. Wong, Introduction to Quantum Computing, Springer. ▪ Matthias Homeister, Quantum Computer verstehen, Springer.
Use of the Module in Other Study Programs	QC in Master Informatik und Systems-Engineering 2024
Specifics and Notes	
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6.18 RA - Reflexion Auslandssemester

Module ID	RA_MaCSN2024
Module Name	Reflexion Auslandssemester
Type of Module	Elective Modules
Recognized Course	RA - Reflection on the semester abroad
ECTS credits	6
Language	deutsch, englisch bei Bedarf
Duration of Module	1 Semester
Recommended Semester	1-2
Frequency of Course	every term
Module Coordinator	Studiengangsleiter(in) Master Technische Informatik / Informatik und Systems-Engineering
Lecturer(s)	verschiedene Dozenten*innen / diverse lecturers

Learning Outcome(s)

> Die Studierenden reflektieren kulturelle, gesellschaftliche und strukturelle Gemeinsamkeiten und Unterschiede ihrer Heimathochschule/-land und der Gasthochschule/-land. Sie werden dadurch in die Lage versetzt, bewusste Entscheidungen hinsichtlich ihrer zukünftigen akademischen und beruflichen Mobilität zu treffen.

> Die Studierenden reflektieren die persönlichen Erfahrungen, die sie während ihres Auslandssemesters gemacht haben, um ihr allgemeines Wertebewusstsein kritisch zu hinterfragen und ggf. zu justieren.

Module Contents

Seminar

> Students are able to reflect on cultural, social and structural similarities and differences between their home university/country and the host university/country. This enables them to make informed decisions regarding their future academic and professional mobility.

> Students can reflect on the personal experiences they have had during their semester abroad in order to critically question and, if necessary, adjust their general awareness of values.

Teaching and Learning Methods	Seminar
Examination Types with Weights	▪ accompanying: oral contribution or term paper or learning portfolio [ungraded]
Workload	180 Hours
Contact Hours	12 Hours ≙ 1 SWS
Self-Study	168 Hours
Recommended Prerequisites	As a rule, a one-semester or longer period of study at a foreign university is a prerequisite for participation.
Mandatory Prerequisites	Seminar requires attendance in the amount of: 1 Termin
Recommended Literature	
Use of the Module in Other Study Programs	▪ RA in Bachelor Elektrotechnik und Informationstechnik 2024 ▪ RA in Bachelor Medientechnologie 2024 ▪ RA in Bachelor Informatik und Systems-Engineering 2024 ▪ RA in Master Elektrotechnik und Informationstechnik 2024 ▪ RA in Master Medientechnologie 2024 ▪ RA in Master Informatik und Systems-Engineering 2024
Specifics and Notes	This course is aimed exclusively at students who have completed a semester abroad.

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6.19 RFSD - RF System Design

Module ID	RFSD_MaCSN2024
Module Name	RF System Design
Type of Module	Elective Modules
Recognized Course	RFSD - RF System Design
ECTS credits	5
Language	englisch
Duration of Module	1 Semester
Recommended Semester	1-2
Frequency of Course	every winter term
Module Coordinator	Prof. Dr. Rainer Kronberger/Professor Fakultät IME
Lecturer(s)	Prof. Dr. Rainer Kronberger/Professor Fakultät IME

Learning Outcome(s)

> In general: Students will learn how high frequency components of wireless communication systems work
> Module-specific:
> students will get a general introduction in rf systems
> they will learn in detail how transmitters and receivers in wireless communication systems work
> they will learn in detail how the components of such systems (LNA, mixer, amplifier, oscillator, etc.) work
> they will learn about limitation effects and noise in such systems
> they will learn how to adapt the components to each other and how to plan and design the complete system (transmitter and / or receiver)

Module Contents

Lecture / Exercises

> RF System, Applications

> Noise in RF systems
> noise classification and characterization
> noise calculation
> noise figure
> noise matching

> Linear and nonlinear circuit behaviour
> theory
> nonlinearities with mixers
> nonlinearities with amplifiers

> RF system components
> receiver componenets
> transmitter components
> frequency generation

Lab

Teaching and Learning Methods	▪ Lecture / Exercises ▪ Lab
Examination Types with Weights	▪ accompanying: exercise lab [ungraded] and ▪ final: (digital) written exam or oral examination [100%]
Workload	150 Hours
Contact Hours	45 Hours ≙ 4 SWS

Self-Study	105 Hours
Recommended Prerequisites	No formal requirements, but students should have knowledge in High Frequency and Microwave Topics
Mandatory Prerequisites	▪ Participation in final examination only after successful participation in Lecture / Exercises ▪ Lab requires attendance in the amount of: 3 Labortermine und 1 Präsentationstermin ▪ Participation in final examination only after successful participation in Lab
Recommended Literature	▪ Kraus & Carver Eletromagnetics, McGraw Hilll, 2006. ▪ Michale Steer, Microwave and RF Design
Use of the Module in Other Study Programs	▪ RFSD in Master Communication Systems and Networks 2020 ▪ RFSD in Master Elektrotechnik und Informationstechnik 2024 ▪ RFSD in Master Medientechnologie 2024 ▪ RFSD in Master Informatik und Systems-Engineering 2024
Specifics and Notes	
Last Update	19.7.2025, 14:32:16

6.20 RP - Research Project

Module ID	RP_MaCSN2024
Module Name	Research Project
Type of Module	Mandatory Module
Recognized Course	RP - Research Project at MaCSN
ECTS credits	10
Language	englisch
Duration of Module	1 Semester
Recommended Semester	2
Frequency of Course	every term
Module Coordinator	Studiengangsleiter(in) Master CSN
Lecturer(s)	

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

Module Contents

Research Project

> As part of the project, the student should work individually on a research topic, analyze a problem in a scientific way, find new or suitable ways to solve the problem, plan the project in a scientific way, conduct experiments, simulations and/or theoretical work, evaluate the results, present the results and write a report.

Teaching and Learning Methods	Research Project
Examination Types with Weights	▪ accompanying: oral contribution or project work [100%]
Workload	300 Hours
Contact Hours	12 Hours ≙ 1 SWS
Self-Study	288 Hours
Recommended Prerequisites	
Mandatory Prerequisites	Participation in final examination only after successful participation in Research Project
Recommended Literature	

Use of the Module in Other Study Programs	RP in Master Communication Systems and Networks 2020
Specifics and Notes	
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6.21 VAE - Virtual Acoustic Environments

Module ID	VAE_MaCSN2024
Module Name	Virtual Acoustic Environments
Type of Module	Elective Modules
Recognized Course	VAE - Virtual Acoustic Environments (VAE)
ECTS credits	5
Language	englisch
Duration of Module	1 Semester
Recommended Semester	1-2
Frequency of Course	every summer term
Module Coordinator	Prof. Dr.-Ing. Christoph Pörschmann/Professor Fakultät IME
Lecturer(s)	Prof. Dr.-Ing. Christoph Pörschmann/Professor Fakultät IME

Learning Outcome(s)

> What: The students learn the basic concepts , the technology and perception-related aspects of cirtual acoustic environemtns. The course will be strongly related to research aspects and projects
> How: The students apply their knowledge on Signal Processing, Audio, and in the field of VR on different aspects of Virtual Acoustic Environements. Actual trends in reseach and state of the art applications will integrated, tested, analyzed and evaluated.
> Aim: The students shall be able to work on research topics which consider topics whic are scientifically new and relevant. Apects of scalability and commercialization play a role

Module Contents

Lecture

> The basic concepts of headphone-based or loudspeaker-based VR-systems are introduced

Project

> 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

Lab

Teaching and Learning Methods	▪ Lecture ▪ Project ▪ Lab
Examination Types with Weights	▪ accompanying: project work [100%] and ▪ accompanying: exercise lab [ungraded]
Workload	150 Hours
Contact Hours	45 Hours ≙ 4 SWS
Self-Study	105 Hours
Recommended Prerequisites	Know-how on Acoustics and audio signal processing
Mandatory Prerequisites	

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"
Use of the Module in Other Study Programs	▪ VAE in Master Communication Systems and Networks 2020 ▪ VAE in Master Medientechnologie 2020 ▪ VAE in Master Medientechnologie 2024 ▪ VAE in Master Technische Informatik 2020 ▪ VAE in Master Informatik und Systems-Engineering 2024
Specifics and Notes	
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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 EL1 - Electives Catalog 1

In diesem Wahlbereich können Master-Module aus dem Angebot der Fakultät 07 der TH Köln und des **FB Informatik** der Hochschule Bonn-Rhein-Sieg mit **technischem Inhalt** frei gewählt werden. Bitte beachten Sie, dass nicht jedes Modul in jedem Jahr angeboten wird.

You must select modules of 10 ECTS credit points in total out of this catalog.

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

- Electives Catalog PFM - Profile Module

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	included in Specialization
ACC	Advanced Channel Coding	5	CS
AMC	Advanced Multimedia Communications	5	N_S
AMS	**Special Aspects of Mobile Autonomous Systems**	**5**	
ARP	**Alternative Rechnerarchitekturen und Programmiersprachen**	**5**	
AVT	**Audio- und Videotechnologien**	**5**	

Module ID	Module Name	ECTS	included in Specialization	
AVV	**Algorithmen der Videosignalverarbeitung**	**5**		
CI	**Computational Intelligence**	**5**		
CSO	**Computersimulation in der Optik**	**5**		
DBT	**Digitale Bildtechnik**	**5**		
DLO	**Deep Learning und Objekterkennung**	**5**		
DMC	**Digital Motion Control**	**5**		
DSP	Digital Signal Processing	5	CS	
EBA	**Elektrische Bahnen**	**5**		
EMM	**Energiemanagement in Energieverbundsystemen**	**5**		
ESD	Embedded Systems Design	5	CS	
HSUT	**Hochspannungsübertragungstechnik**	**5**		
IBD	**InnoBioDiv**	**5**		
IIS	**Intelligent Information Systems**	**5**		
ITF	IT-Forensik	5		N_S
KOGA	**Kombinatorische Optimierung und Graphenalgorithmen**	**5**		
KRY	Cryptography	5	CS	N_S
KVS	Kommunikation in verteilten Systemen	5		N_S
LCSS	**Large and Cloud-based Software-Systems**	**5**		
LSPW	**Leistungselektronische Stellglieder für PV- und Windkraftanlagen**	**5**		
MCI	**Mensch-Computer-Interaktion**	**5**		
MLWR	Maschinelles Lernen und wissenschaftliches Rechnen	5	CS	
NGN	Next Generation Networks	5		N_S
NLO	**Nichtlineare Optik**	**5**		
OSA	**Optische Spektroskopie und Anwendungen**	**5**		
PAP	**Parallele Programmierung**	**5**		
QEKS	**Qualitätsgesteuerter Entwurf komplexer Softwaresysteme**	**5**		
RFSD	RF System Design	5	CS	
RM	**Rastermikroskopie**	**5**		
SIM	**Simulation in der Ingenieurswissenschaft**	**5**		
SNEE	**Stromnetze für erneuerbare Energien**	**5**		
SYE	**Systemtechnik für Energieeffizienz**	**5**		
TED	**Theoretische Elektrodynamik**	**5**		
THI	**Theoretische Informatik**	**5**		
TSVP	**Technologien und Systeme der Videoproduktion**	**5**		
VAE	Virtual Acoustic Environments	5	CS	
VER	**Virtuelle und erweiterte Realität**	**5**		

Modules of other faculties or universities:

Affiliation	Module Name	ECTS	included in Specialization
Hochschule Bonn-Rhein-Sieg	Delegated Authorization	6	N_S
Hochschule Bonn-Rhein-Sieg	Selected Topics in Network Security	6	N_S
Hochschule Bonn-Rhein-Sieg	Kommunikation in verteilten Systemen	6	N_S
Universidad Politécnica de Madrid	Distributed Systems for IoT	5	N_S

7.2 EL2 - Electives Catalog 2

In diesem Wahlbereich können Master-Module aus dem Angebot der Fakultät 07 der TH Köln und der Hochschule Bonn-Rhein-Sieg frei gewählt werden. Bitte beachten Sie, dass nicht jedes Modul in jedem Jahr angeboten wird.
You must select modules of 5 ECTS credit points in total out of this catalog.

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

- Electives Catalog EL1 - Electives Catalog 1

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	included in Specialization	
ACC	Advanced Channel Coding	5	CS	
AMC	Advanced Multimedia Communications	5		N_S
AMS	Special Aspects of Mobile Autonomous Systems	5		
ARP	Alternative Rechnerarchitekturen und Programmiersprachen	5		
AVT	Audio- und Videotechnologien	5		
AVV	Algorithmen der Videosignalverarbeitung	5		
CI	Computational Intelligence	5		
CSO	Computersimulation in der Optik	5		
DBT	Digitale Bildtechnik	5		
DLO	Deep Learning und Objekterkennung	5		
DMC	Digital Motion Control	5		
DSP	Digital Signal Processing	5	CS	
EBA	Elektrische Bahnen	5		
EMM	Energiemanagement in Energieverbundsystemen	5		
ESD	Embedded Systems Design	5	CS	
HSUT	Hochspannungsübertragungstechnik	5		
IBD	InnoBioDiv	5		
IIS	Intelligent Information Systems	5		
ITF	IT-Forensik	5		N_S
KOGA	Kombinatorische Optimierung und Graphenalgorithmen	5		
KRY	Cryptography	5	CS	N_S
KVS	Kommunikation in verteilten Systemen	5		N_S
LCSS	Large and Cloud-based Software-Systems	5		
LSPW	Leistungselektronische Stellglieder für PV- und Windkraftanlagen	5		
MCI	Mensch-Computer-Interaktion	5		
MLWR	Maschinelles Lernen und wissenschaftliches Rechnen	5	CS	
NGN	Next Generation Networks	5		N_S
NLO	Nichtlineare Optik	5		
OSA	Optische Spektroskopie und Anwendungen	5		
PAP	Parallele Programmierung	5		
QEKS	Qualitätsgesteuerter Entwurf komplexer Softwaresysteme	5		

Module ID	Module Name	ECTS	included in Specialization
RFSD	RF System Design	5	CS
RM	Rastermikroskopie	5	
SIM	Simulation in der Ingenieurswissenschaft	5	
SNEE	Stromnetze für erneuerbare Energien	5	
SYE	Systemtechnik für Energieeffizienz	5	
TED	Theoretische Elektrodynamik	5	
THI	Theoretische Informatik	5	
TSVP	Technologien und Systeme der Videoproduktion	5	
VAE	Virtual Acoustic Environments	5	CS
VER	Virtuelle und erweiterte Realität	5	

Modules of other faculties or universities:

Affiliation	Module Name	ECTS	included in Specialization
Hochschule Bonn-Rhein-Sieg	Delegated Authorization	6	N_S
Hochschule Bonn-Rhein-Sieg	Selected Topics in Network Security	6	N_S
Hochschule Bonn-Rhein-Sieg	Kommunikation in verteilten Systemen	6	N_S
Universidad Politécnica de Madrid	Distributed Systems for IoT	5	N_S

7.3 EL3 - Elective 3

Für dieses Wahlmodul können beliebige Master-Module aus dem Angebot der TH Köln und der Hochschule Bonn-Rhein-Sieg nach Angebot frei gewählt werden. Erfragen Sie jedoch, welche Voraussetzungen der Lehrende für den Besuch des Moduls erwartet. Diese müssen erfüllt sein, um das Modul besuchen zu können Weitere Module können nur nach vorhergehender Absprache mit der Studiengangsleitung gewählt werden. Bitte beachten Sie bei Ihrer Planung auch, dass die Lehrveranstaltungen in der Regel nur im Sommer- oder Wintersemester angeboten werden. Beachten Sie auch, dass nicht alle Module jedes Jahr angeboten werden.
You must select modules of 5 ECTS credit points in total out of this catalog.

7.4 PFM - Profile Module

In diesem Wahlbereich sind die Module aufgeführt, die einem der Studienschwerpunkte zugeordnet sind.
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:

- Specialization CS - Communication Systems
- Specialization N_S - Networks & Security

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	included in Specialization
ACC	Advanced Channel Coding	5	CS
AMC	Advanced Multimedia Communications	5	N_S
DSP	Digital Signal Processing	5	CS
ESD	Embedded Systems Design	5	CS
ITF	IT-Forensik	5	N_S
KRY	Cryptography	5	CS N_S
KVS	Kommunikation in verteilten Systemen	5	N_S
MLWR	Maschinelles Lernen und wissenschaftliches Rechnen	5	CS
NGN	Next Generation Networks	5	N_S
RFSD	RF System Design	5	CS
VAE	Virtual Acoustic Environments	5	CS

Modules of other faculties or universities:

Affiliation	Module Name	ECTS	included in Specialization
Hochschule Bonn-Rhein-Sieg	Delegated Authorization	6	N_S
Hochschule Bonn-Rhein-Sieg	Selected Topics in Network Security	6	N_S
Hochschule Bonn-Rhein-Sieg	Kommunikation in verteilten Systemen	6	N_S
Universidad Politécnica de Madrid	Distributed Systems for IoT	5	N_S

8. Specializations

The following section describes the specializations defined in this degree program (see also §24 of the examination regulations). The following information and regulations apply to all specializations:

- A specialization is deemed to have been successfully completed if modules listed therein amounting to at least 20 ECTS have been successfully completed.
- The completed specializations are listed in a separate annex to the degree certificate.
- Upon application, further suitable modules can be added to a specialization. Such an application must be submitted informally to the head of degree program at least six months before the planned participation in a module to be supplemented. The examination board decides on the acceptance of the application in consultation with the head of degree program and suitable teaching staff.

8.1 CS - Communication Systems

Kommunikationssysteme und deren Funktionalität Absolventen können kommunikationstechnische Systeme entwerfen, aufbauen, erweitern und entwickeln. Sie verfügen über HW und SW Kenntnisse und finden Arbeitsplätze in F&E Bereichen der IKT sowie als Allrounder in allen Bereichen der Industrie und Wirtschaft. Die weiter fortschreitende totale Vernetzung der Dinge (Internet of Things) und die Digitalisierung der Produktion eröffnen langfristig Berufsmöglichkeiten für Absolventen des Studiengangs. Absolventen des Communication Systems Profils arbeiten hier im Speziellen zum Entwurf von Hardware, Firmware und Aufbau von funkbasierten Sensornetzen.

Modules of the faculty:

Module ID	Module Name	ECTS
ACC	Advanced Channel Coding	5
VAE	Virtual Acoustic Environments	5
RFSD	RF System Design	5
ESD	Embedded Systems Design	5
KRY	Cryptography	5
DSP	Digital Signal Processing	5
MLWR	Maschinelles Lernen und wissenschaftliches Rechnen	5

8.2 N_S - Networks & Security

Vernetzung und Sicherheit von Netzwerken und Komponenten. Absolventen dieses Profils finden Ihre beruflichen Herausforderungen im Bereich der Vernetzung von Geräten und Dingen (IoT, Industrie 4.0) und der informationstechnischen Sicherheit . Alle Branchen der Industrie, die Wirtschaft und die öffentliche Verwaltung benötigen heute Experten aus diesen Gebieten. Dabei übersteigt die Nachfrage das Angebot.

Modules of the faculty:

Module ID	Module Name	ECTS
NGN	Next Generation Networks	5
AMC	Advanced Multimedia Communications	5
ITF	IT-Forensik	5
KRY	Cryptography	5
KVS	Kommunikation in verteilten Systemen	5

Modules of other faculties or universities:

Affiliation	Module Name	ECTS
Hochschule Bonn-Rhein-Sieg	Delegated Authorization	6
Hochschule Bonn-Rhein-Sieg	Selected Topics in Network Security	6
Hochschule Bonn-Rhein-Sieg	Kommunikation in verteilten Systemen	6
Universidad Politécnica de Madrid	Distributed Systems for IoT	5

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 - Entwicklung und Design	HF2 - Forschung und Innovation	HF3 - Leitung und Management	HF4 - Qualitätssicherung und Te...	K.1 - Entwicklung und Konzeptio...	K.2 - Prüfung und Bewertung kom...	K.3 - Wissenschaftliches Arbeit...	K.4 - Projektmanagement und Tea...	K.5 - Selbstorganisation und au...	K.6 - Kommunikation und interku...	K.7 - Technische und naturwisse...	K.8 - Nachhaltigkeit und gesell...	K.9 - Analyse, Simulation und A...	K.10 - Führungs- und Entscheidun...	K.11 - Anwendung ethischer Werte...	K.12 - Integratives Denken und H...	K.13 - Innovation und Kreativitä...	SK.1 - Global Citizenship	SK.2 - Internationalisierung	SK.3 - Interdisziplinarität	SK.4 - Transfer
ACC	Advanced Channel Coding	●	●		●	●	●	●	●	●				●	●		●	●	●	●		
AMC	Advanced Multimedia Communications	●	●		●	●	●	●	●	●	●			●				●		●		
BSN	Basics on Systems and Networks		●		●		●			●		●		●						●	●	
DSP	Digital Signal Processing	●	●		●	●	●	●		●				●			●			●		
ESD	Embedded Systems Design	●				●	●		●	●	●	●		●				●		●	●	●
HIM	Advanced Mathematics				●		●	●						●						●		
IBD	InnoBioDiv					●	●	●		●	●	●						●	●	●	●	●
ITF	IT-Forensik	●			●	●	●	●	●	●				●	●		●	●				
KOLL	Kolloquium zur Masterarbeit	●	●	●	●					●	●											
KRY	Cryptography	●	●		●	●	●			●				●						●		
KVS	Communication in Distributed Systems and Networks	●	●		●		●	●						●						●		
LCSS	Large and Cloud-based Software-Systems	●	●	●	●	●	●	●	●	●	●	●		●			●	●		●		●
MAA	Masterarbeit	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●
MLWR	Maschinelles Lernen und wissenschaftliches Rechnen							●		●			●	●		●	●	●			●	●
NGN	Next Generation Networks	●	●		●	●	●	●	●	●	●			●				●		●		
PM	Project Management	●					●			●	●	●		●						●	●	

Abbr.	Module Name	HF1 - Entwicklung und Design	HF2 - Forschung und Innovation	HF3 - Leitung und Management	HF4 - Qualitätssicherung und Te...	K.1 - Entwicklung und Konzeptio...	K.2 - Prüfung und Bewertung kom...	K.3 - Wissenschaftliches Arbeit...	K.4 - Projektmanagement und Tea...	K.5 - Selbstorganisation und au...	K.6 - Kommunikation und interku...	K.7 - Technische und naturwisse...	K.8 - Nachhaltigkeit und gesell...	K.9 - Analyse, Simulation und A...	K.10 - Führungs- und Entscheidun...	K.11 - Anwendung ethischer Werte...	K.12 - Integratives Denken und H...	K.13 - Innovation und Kreativitä...	SK.1 - Global Citizenship	SK.2 - Internationalisierung	SK.3 - Interdisziplinarität	SK.4 - Transfer
QC	Quantum Computing	●	●																	●		
RA	Reflexion Auslandssemester																	●	●	●		
RFSD	RF System Design		●		●	●	●	●			●			●				●		●	●	
RP	Research Project	●	●	●	●	●	●	●		●	●	●		●		●		●		●	●	
VAE	Virtual Acoustic Environments	●	●		●	●	●	●	●						●		●				●	●

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
4.2	current	1. Distributed Systems for IoT in Schwerpunkt Networks and Security in MaCSN	Link
4.1	2024-11-29-12-00-00	1. Version zur Abstimmung im Fakultätsrat	Link
4.0	2024-11-29-12-00-00	1. Begutachtete Version für Reakkreditierung 2024 2. Neues Layout für sämtliche Modulhandbücher	Link

Impressum | Datenschutzhinweis | Haftungshinweis | Bei Fehlern, bitte Mitteilung an die modulhandbuchredaktion@f07.th-koeln.de