Technology
Arts Sciences
TH Köln

Faculty of Information, Media and Electrical Engineering

Master Media Technology PO4

Module Manual

Version: 4.4.2025-09-18-14-14-22.5fce3ccf
The most recent version of this handbook can be found here:
https://f07-studieninfo.web.th-koeln.de/mhb/current/en/MaMT2024.html

1. Program Description

The Master's degree course in Media Technology deepens your theoretical and practical knowledge of the development of complex media technologies under interdisciplinary conditions and should enable you to work scientifically and to apply and expand scientific knowledge. In addition to specialist skills, a key qualification is the ability to work successfully and efficiently in a team on complex technical tasks under interdisciplinary conditions.

Occupational fields and sectors

Media technology graduates can work in the field of research and development in many sectors. These include the broadcasting and telecommunications industry, audio and video technology, entertainment industry, internet companies, automotive industry, medical technology, industrial automation, surveillance technology, manufacturers of (special) cameras, multimedia technology, CAD and 3D application development, as well as research institutes. For example, you will work as a development and planning engineer or in research with the prospect of taking on management and project responsibility.

Course of study

The course extends over 3 semesters, whereby it is possible to start in both the winter and summer semesters. In the first two semesters, students take 6 different elective modules and 3 compulsory modules; the 3rd semester is reserved for the Master's thesis and the colloquium.

The degree program offers a broad spectrum of knowledge in the field of media technology, which is based on 3 specializations (see list on next page). This allows you to set individual priorities in your studies without restricting the necessary breadth. The modules from these 3 specializations are available for the elective modules, of which at least 3 must be selected. Further modules from the range offered by the technical faculties of TH Köln can also be selected. If desired, one of the 6 elective modules can come from a non-technical faculty. This allows you to round off your profile by incorporating interdisciplinary skills. Students can specialize and choose up to 2 major fields of study.

Students who have passed at least 3 elective modules in a specialization have successfully completed the specialization. However, students can also choose not to take a specialization and, for example, take 2 modules from different specializations.

A special feature of the course is the Master's project. Here you develop a sophisticated technical system in a group, from the project idea and conception to the realization, testing and acceptance of the system. Here you can combine your knowledge and skills from the various fields of media technology in a team and acquire skills in the area of project implementation and responsibility. The compulsory module “Applied Mathematics” must be taken by all students, as it teaches skills in the field of mathematics that go beyond those taught in the Bachelor's degree and which are necessary to achieve the study objectives in the field of scientific education.

The two compulsory modules “Master's main seminar” and “Master's project” are offered every semester. It has been shown in the past that this flexible arrangement is particularly advantageous for students who have obtained their Bachelor's degree at other universities in order to give them a good start to their studies. You will find the study plan on the next page.

Expectations of applicants

The Master's degree course in Media Technology is consecutive to the Bachelor's degree course of the same name. However, under certain conditions it is also open to graduates from other fields of study, e.g. computer science, physics or electrical engineering.

Even more so than on the Bachelor's degree course, you should have a high level of motivation and commitment to independently explore challenging topics in media technologies. This also requires you to work independently and enjoy getting to the bottom of complex issues.

2. Graduate Profile

Graduates of the M. Sc. Media Technology degree program are able to develop, research and manage media technology systems with scientific depth and an interdisciplinary approach. They take responsibility for innovations in research and industry, actively shape complex developments in the fields of audio, video, VR/AR, AI and embedded systems and qualify for management positions or an academic career. In contrast to the Bachelor's degree, the focus is on research skills, in-depth system development and management responsibility.

The Master's degree course in Media Technology builds consistently on the foundations acquired in the Bachelor's degree course, but systematically expands these with research-oriented, analytical and management skills. While the Bachelor's course provides a broad technical qualification with a strong application orientation, the Master's course focuses on scientific in-depth study, systemic complexity and the ability to shape innovations in a dynamic technological and social environment.

The focus is on:

- The independent handling of challenging technical issues,
- The ability to conduct scientifically sound research and development,
- The assumption of responsibility in interdisciplinary teams, projects and organizations.

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

- They design, analyze and evaluate complex media technology systems incorporating the latest scientific findings and technologies (e.g. VR/AR, deep learning, image and signal processing, embedded systems, audiovisual coding).
- They are able to plan and implement technical systems taking into account ethical, social, ecological and economic aspects.
- They take on leadership and management tasks in interdisciplinary project teams and lead research and development projects.
- Through the Master's project, they acquire distinctive skills in the conception, realization and presentation of complex systems in a realistic project environment.
- They master scientific work at a high level and thus qualify for doctoral studies.
- Strong communication skills, intercultural sensitivity and the ability to organize themselves make them competent specialists and managers in an international environment.
- The Master's qualifies students for careers in research and development, technical management, software development, product management, media production, system integration and other areas of innovation - or for further academic qualifications.

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.	Name	Catalog (WB) Elective Mandatory (PF)	ECTS
1	WBK	Wahlbereich Kerngebiet	WB	15
	AMA	Angewandte Mathematik	PF	5
	SEM	Masterhauptseminar Medientechnologie	PF	10
2	WBT	Wahlbereich Technische Module	WB	10
	WBA	Wahlbereich Allgemein	WB	5
	MP	Masterprojekt	PF	15
3	MAA	Masterarbeit	PF	27
	KOLL	Kolloquium zur Masterarbeit	PF	3

5.2 Alternativer Studienverlaufsplan

Sem.	Abbr.	Name	Catalog (WB) Elective Mandatory (PF)	ECTS
1	AMA	Angewandte Mathematik	PF	5
	WBK	Wahlbereich Kerngebiet	WB	10
2	WBK	Wahlbereich Kerngebiet	WB	5
	WBT	Wahlbereich Technische Module	WB	10
3	WBA	Wahlbereich Allgemein	WB	5
	SEM	Masterhauptseminar Medientechnologie	PF	10
4	MP	Masterprojekt	PF	15
5	KOLL	Kolloquium zur Masterarbeit	PF	3
	MAA	Masterarbeit	PF	27

6. Modules

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

6.1 AMA - Angewandte Mathematik

Module ID	AMA
Module Name	Angewandte Mathematik
Type of Module	Mandatory Module
Recognized Course	AMA - Applied Matheamtics
ECTS credits	5
Language	deutsch, englisch bei Bedarf
Duration of Module	1 Semester
Recommended Semester	1
Frequency of Course	every summer term
Module Coordinator	Prof. Dr. Stefan Grünvogel/Professor Fakultät IME
Lecturer(s)	Prof. Dr. Stefan Grünvogel/Professor Fakultät IME

Learning Outcome(s)

WAS:
Eine mathematische Beschreibung einer medientechnologischen Aufgabenstellung ableiten bzw. ein mathematisches Modell eines medientechnologischen Systems entwerfen.

WOMIT:
Durch Definition von Systemgrenzen sowie der Beschreibung mit Hilfe mathematischer Notation und formaler Sprache.

WOZU:
Um die Aufgabenstellung mit Hilfe mathematischer Algorithmen lösen zu können bzw. einer Simulation zu erstellen.

WAS:
Geeignete numerische Lösungs- bzw. Simulationsverfahren für ein gegebenes Problem (Simulation eines System, Lösen einer Aufgabenstellung) auswählen.

WOMIT:
Analyse und Kenntnisse der grundlegenden theoretischen Eigenschaften (Kondition, Stabilität, Rechenaufwand) mathematischer Algorithmen.
Die zugehörige Theorien und ihre Grenzen kennen und verstehen.
Selbsständiges

WOZU:
Um nach Wahl des Verfahrens das passendes Softwaresystem auswählen zu können bzw. eigene numerische Verfahren zu implementieren.

WAS:
Numerische Verfahren zu Lösung für ein gegebenes Problem anwenden

WOMIT:
Verwendung von vorhandener Softwaresystemen und / oder Implementierung eigener numerischer Verfahren zu Lösung einer Aufgabenstellung.

WOZU:
Um letztendlich eine die Aufgabenstellung zu lösen um damit zu wissenschaftliche Erkenntnisse zu gelangen oder komplexe Medientechnologien zu entwickeln.

WAS:
Bewertung und Dokumentation der Ergebnisse der numerischer Verfahren.

WOMIT:
Eine Bewertung der Ergebnisse basiert auf den Kenntnissen der Eigenschaften der verwendeten Algorithmen (Kondition, Stabilität, Rechenaufwand). Zur Dokumentation wird die mathematische korrekte Notation und formale Sprache verwendet.

WOZU:
Um die erlangten wissenschaftlichen Erkenntnisse bzw. Lösungen richtig einzuschätzen und in interdisziplinärem Kontext zu kommunizieren.

Module Contents

Seminar

> Knowledge of numerical mathematics is taught according to the Flipped Classroom concept.
>
> Topcis:
> Numerics and error analysis
> Solving linear equations (direct, iterative)
> eigen vectors
> singular value decomposition
> solving nonlinear equations
> nonlinear least-squares
> optimization methods
> interpolation
> intergration and differentiation
> numerical software

Project

> Mathematical description of a complex media technology problem which requires at least the knowledge conveyed in the seminar part of the course in order to be solved.
> Analysis of the problem and selection of a solution methode based on this.
> Selection of a software system or implementation of a corresponding algorithmic solution method.
> Written documentation and critical evaluation of the results.
> Explanation of the individual work steps

Teaching and Learning Methods	▪ Seminar ▪ Project
Examination Types with Weights	▪ accompanying: term paper [ungraded] and ▪ final: project work or oral examination or oral contribution [100%]
Workload	150 Hours
Contact Hours	23 Hours ≙ 2 SWS
Self-Study	127 Hours
Recommended Prerequisites	The classical topics in engineering mathematics: - analysis of one and several variables (differentiation, intergration, Taylor) - linear algebra (general vector spaces, linear mappings, matrices, vectors, norm, scalar product)
Mandatory Prerequisites	
Recommended Literature	▪ Solomin: Numerical Algorithms, CRC Press ▪ Chapra,Canale: Numerical Methods for Engineers, McGraw-Hill ▪ Quarteroni, Saleri, Gervasio: Scientific Computing with MATHLAB and Octave, Springer ▪ Dahmen, Reusken: Numerik für Ingenieure und Naturwissenschaftler, Springer ▪ Deuflhard, Hohmann: Numerische Mathematik 1, de Gruyter
Included in Elective Catalog	
Included in Specialization	
Use of the Module in Other Study Programs	AMA in Master Medientechnologie PO3
Specifics and Notes	
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6.2 ATM - Ausgewählte Themen der Medientechnologie

Module ID	ATM
Module Name	Ausgewählte Themen der Medientechnologie
Type of Module	Elective Modules
Recognized Course	HI - Haptic interfaces
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	Prof. Dr.-Ing. Arnulph Fuhrmann/Professor Fakultät IME
Lecturer(s)	Dr. Civelek Turhan/wissenschaftlicher Mitarbeiter Fakultät IME

Learning Outcome(s)

- Die Studierenden verstehen und erklären die haptische Wahrnehmung durch theoretische Konzepte und praktische Anwendungen, identifizieren Entwicklungsplattformen für haptische Anwendungen durch die Kombination von Theorie und Praxis, erkennen haptische Schnittstellenpositionen durch theoretisches Wissen und praktische Erfahrung und entwickeln immersive Virtual-Reality-Anwendungen mit haptischem Feedback.

- Die Studierenden sind in der Lage, Steuerungen für die Teleoperation zu identifizieren und zu implementieren, um eine zuverlässige Fernsteuerung von Geräten zu ermöglichen, Stabilitätsprobleme in VR- und Teleoperationssystemen zu beheben, Tests für die Benutzerwahrnehmung und das Feedback in haptischen Systemen und virtuellen Umgebungen zu entwickeln, Anwendungsbereiche haptischer Geräte in verschiedenen Bereichen wie Medizin, Spiele, Simulation und Rehabilitation zu erläutern, aktuelle VR- und Haptik-Technologien und ihre ethischen und sozialen Auswirkungen durch die Kombination von Theorie und kritischem Denken zu diskutieren, Haptik- und VR-Forschung zu bewerten, um Stärken, Schwächen und die Qualität der Forschung zu ermitteln, und Forschungspräsentationen zu haptischen Schnittstellen und virtueller Realität zu entwerfen.

WOMIT:
Die Kompetenzen werden zunächst über die Vorlesung durch die Dozenten vermittelt und danach im Praktikum anhand konkreter Aufgabenstellung von den Studierenden vertieft. Im Präsentationsteil der Lehrveranstaltung recherchieren die Studierenden anhand von Fachartikeln und anderen Informationsquellen neue Konzepte der virtuellen und erweiterten Realität mit Haptik zu vorgegebenen Themen und stellen diese in einer Präsentation vor.

WOZU:
Die sichere Anwendung der Grundlagen von Virtual Reality mit Haptik ist eine Voraussetzung für die Entwicklung komplexer interaktiver haptischer Anwendungen und Systeme. Darüber hinaus ermöglicht das Grundlagenwissen die Bewertung bestehender Systeme und wissenschaftlicher Arbeiten im Bereich der Haptik.

Module Contents

Lecture

Description of input and output devices as well as specific hardware for haptic and virtual reality

Describe the areas of application of haptic devices, data structures and algorithms in VR applications.

Describing haptic user interfaces: Presentation, interaction and navigation in virtual 3D scenarios with force feedback.

Explain algorithmic and mathematical principles for tracking, rendering and collision detection.

Describe stability issues in VR and teleoperation systems due to latency, haptics, control and image quality.

Describe VR and haptic technologies and their ethical and social implications.

Describe critical thinking to identify strengths, weaknesses and quality of research

Research Project

- Recognize basic characteristics of haptic devices, perception and interfaces.
- Developing VR applications with haptic devices and analyzing haptic systems.
- Testing haptic systems and procedures and evaluating scientific information and contexts.
- Presenting own scientific results, applying methods of haptic systems.
- Implementing basic teleoperation controls, taking into account stability and ethical aspects.
- Designing tests and reflecting on ethical aspects of haptic VR technologies.
- Self-organization and application of linguistic and intercultural skills.

Teaching and Learning Methods	▪ Lecture ▪ Research Project
Examination Types with Weights	▪ accompanying: project work [100%]
Workload	150 Hours
Contact Hours	34 Hours ≙ 3 SWS
Self-Study	116 Hours
Recommended Prerequisites	Bachelor level knowledge of VR, AR and XR and software language skills such as C#, C++ and Python
Mandatory Prerequisites	Research Project requires attendance in the amount of: 6 Termine
Recommended Literature	▪ Thorsten A. Kern, et al., Engineering Haptic Devices, Springer International Publishing, 2023. ▪ Matjaž Mihelj, Janez Podobnik, Haptics for Virtual Reality and Teleoperation, Springer Dordrecht, 2012.
Included in Elective Catalog	▪ WBA - Wahlbereich Allgemein ▪ WBT - Wahlbereich Technische Module
Included in Specialization	
Use of the Module in Other Study Programs	ATM in Master Medientechnologie PO3
Specifics and Notes	
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6.3 AVT - Audio- und Videotechnologien

Module ID	AVT
Module Name	Audio- und Videotechnologien
Type of Module	Elective Modules
Recognized Course	AVT - Audio and Video Technologies
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	Prof. Dr.-Ing. Klaus Ruelberg/Professor Fakultät IME
Lecturer(s)	Prof. Dr.-Ing. Klaus Ruelberg/Professor Fakultät IME

Learning Outcome(s)

> Was:
> Audio- und Videotechnologien kommen in vielfältiger Weise in der Medienindustrie zum Einsatz. Die Mediendistributionskette, die im Rahmen der LV als exemplarische Anwendung herangezogen und analysiert wird, umfasst verschiedene Technologien wie Datenkompression, Audio- und Videosignalverarbeitung Fehlerschutzmechanismen, digitale Modaluationsverfahren.
> Womit:
> Studierende durchdringen eigenständig ausgewählte Themengebiete der Audio- und Videotechnologien, bereiten diese auf und halten einen Fachvortrag.
> In einem in die LV integrierter Übungsblock entwickeln die Studierende eigenständig algorithmische Lösungskonzepte und setzen diese programmtechnsich um.
> Wozu:
> Die Studierenden können akuelle Verfahren zur Audio- und Videocodierung entwickeln und in Hard- und Software implementieren. Sie können Mediendistributionsketten planen, beurteilen und umsetzen sowie fachliche Führungs- und Projektverantwortung übernehmen

Module Contents

Lecture / Exercises

> Audio and video source coding
>
> Channel models, channel coding (FEC & digital modulation principles)
>
> Broadcast transmission systems (DVB - Digtal Video Broadcasting)
>
> implement audio and video coding methods in hard and software
>
> develope algorithms and methods for audio and videocoding
>
> delvelope and implement digital broadcasting systems

Exercises / Lab

Teaching and Learning Methods	▪ Lecture / Exercises ▪ Exercises / Lab
Examination Types with Weights	▪ accompanying: oral contribution [ungraded] and ▪ final: oral examination or (digital) written exam [100%]
Workload	150 Hours
Contact Hours	57 Hours ≙ 5 SWS
Self-Study	93 Hours

Recommended Prerequisites	none
Mandatory Prerequisites	Exercises / Lab requires attendance in the amount of: 1 Termin
Recommended Literature	▪ Proakis, J. Salehi, M. (2007) Digital Communications. McGraw-Hill. ISBN 978-0072957167 ▪ Reimers, U. (2001) Digital Video Broadcasting. Springer Verlag. ISBN 978-3-662-04562-6
Included in Elective Catalog	▪ WBA - Wahlbereich Allgemein ▪ WBK - Wahlbereich Kerngebiet ▪ WBT - Wahlbereich Technische Module
Included in Specialization	TSA - Technologien und Systeme audiovisueller Medien
Use of the Module in Other Study Programs	▪ AVT in Master Communication Systems and Networks PO3 ▪ AVT in Master Communication Systems and Networks PO4 ▪ AVT in Master Medientechnologie PO3 ▪ AVT in Master Technische Informatik PO3 ▪ AVT in Master Informatik und Systems-Engineering PO1
Specifics and Notes	
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6.4 AVV - Algorithmen der Videosignalverarbeitung

Module ID	AVV
Module Name	Algorithmen der Videosignalverarbeitung
Type of Module	Elective Modules
Recognized Course	AVV - Algorithms for video signal processing
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	Prof. Dr.-Ing. Klaus Ruelberg/Professor Fakultät IME
Lecturer(s)	Prof. Dr.-Ing. Klaus Ruelberg/Professor Fakultät IME

Learning Outcome(s)

> WAS:
> Studierende formulieren gemeinsam mit dem Dozenten eine Aufgabenstellung/Forschungsfrage im Bereich der Videosignalverarbeitung. Unter Anwendung wissenschaftlicher Methoden analysieren sie die Aufgaben- bzw. Fragestellung eigenständig und entwickeln algorithmische Lösungsansätze.
> WOMIT:
> Eine Recherche der wissenschaftlichen Literatur bildet die Basis für die Studierenden, um die Aufgabenstellung inhaltlich zu durchdringen und einordnen zu können. Verschiedene, als geignet erscheinende Lösungsansätze werden entwickelt und gegenübergestellt. Mithilfe geeigneter Entwicklungstools (z.B. Matlab) werden die entwickleten Algorithmen umgesetzt und bzgl. der Aufgabenstellung beurteilt. Die erzielten Ergebnisse des Projektes werden in einem Bericht zusammengefasst und im Rahmen eines Vortrages präsentiert.
> WOZU:
> Studierenden erhalten die Möglichkeit, sich tiefergehend mit einer wissenschaftlich/entwicklerischen Aufgabenstellung zu befassen.

Module Contents

Project

> The students are introduced to different algorithmic approaches of video signal processing and get an overview of current applications and questions.

> Analyzing, developing, implementing and evaluating algorithms for video signal processing

Teaching and Learning Methods	Project
Examination Types with Weights	▪ accompanying: project work [100%]
Workload	150 Hours
Contact Hours	12 Hours ≙ 1 SWS
Self-Study	138 Hours
Recommended Prerequisites	keine
Mandatory Prerequisites	Project requires attendance in the amount of: 70% der Praktikumstermine und 1 Präsentation (typischerweise 5 Termine)
Recommended Literature	▪ Signal, Image and Video Processing (Journal), Springer Verlag, Electronic ISSN 1863-1711 ▪ Machine Learning for Audio, Image and Video Analysis, Francesco Camastra, Alessandro Vinciarelli, Springer London, 2016, ISBN978-1-4471-6840-9

Included in Elective Catalog	▪ WBA - Wahlbereich Allgemein ▪ WBK - Wahlbereich Kerngebiet ▪ WBT - Wahlbereich Technische Module
Included in Specialization	BIL - Bildtechnologie
Use of the Module in Other Study Programs	▪ AVV in Master Communication Systems and Networks PO3 ▪ AVV in Master Communication Systems and Networks PO4 ▪ AVV in Master Medientechnologie PO3 ▪ AVV in Master Technische Informatik PO3 ▪ AVV in Master Informatik und Systems-Engineering PO1
Specifics and Notes	
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6.5 DBT - Digitale Bildtechnik

Module ID	DBT
Module Name	Digitale Bildtechnik
Type of Module	Elective Modules
Recognized Course	DBT - Digital Imaging
ECTS credits	5
Language	deutsch
Duration of Module	1 Semester
Recommended Semester	1-2
Frequency of Course	every winter term
Module Coordinator	Prof. Dr. Gregor Fischer/Professor Fakultät IME
Lecturer(s)	Prof. Dr. Gregor Fischer/Professor Fakultät IME

Learning Outcome(s)

> Was:
> Digitale Bildtechniken kommen in vielfältiger Weise in der Medienindustrie zum Einsatz. Die Bildkette digitaler Kameras, die im Rahmen der LV als exemplarische Anwendung herangezogen und analysiert wird, umfasst verschiedene Technologien wie Farbbildtechnik, HDR-Bildtechnik oder bildtechnische Verfahren.
>
> Womit:
> Durch die Vorlesung werden theoretische Kenntnisse der Bildtechnik exemplarisch vermittelt und in Zusammenhang mit den aktuellen Entwicklungen gebracht.
> In einem in die LV integrierten begleitenden Praktikum entwickeln die Studierenden eigenständig algorithmische Lösungskonzepte und setzen diese in Matlab-Programme um.
>
> Wozu:
> Die Studierenden können akuelle Verfahren zur digitalen Bildtechnik entwickeln und in Hard- und Software implementieren. Sie können bildtechnische Verfahren analysieren, beurteilen und umsetzen sowie fachliche Führungs- und Projektverantwortung übernehmen.

Module Contents

Lecture / Exercises

Color Imaging
Color capturing with electronic sensors
Color detectors
Demosaicking
Optical antialiasing filters
Color management for DSCs
ICC profiles computing with least squares fit
Testing color accuracy
Color appearance models
Multispectral Imaging
Spectral sensitivities estimation by means of a general method to stabilize an instable set of linear equations
Statistics of natural spectra (Principal Components Analysis)
Spectral stimulus estimation

HDR Imaging
HDR capturing technology
Contrast management
photo receptor model
unsharp masking
retinex algorithm
Automatic control

Imaging Methods
Automatic white balancing
Grey world approach
Color-by-Correlation
Dichromatic reflection model
MTF management
MTF measurement
filter design for MTF optimization and sharpening
Adaptive sharpening
Denoising
Modelling of sensor noise
Locally adaptive smoothing filter
Wiener filtering
Bilateral filtering
Non-Local-Means filtering
Defect pixel / cluster correction

Describe the function and effects of different imaging methods

Lab

analyse optical and electronic imaging characteristics

recognize and assess imaging defects

realize imaging methods by software programmin according to a given specification or scientific paper

measure optical and electronic imaging characteristics or defects

implement new imaging methods according to a given specification or scientific paper

optimize imaging methods by basic mathematical optimization methods

compare image quality of different imaging methods

document results

Teaching and Learning Methods
- Lecture / Exercises
- Lab

Examination Types with Weights	▪ accompanying: lab report or exercise lab [ungraded] and ▪ final: project work or oral examination or oral contribution [100%]
Workload	150 Hours
Contact Hours	45 Hours ≙ 4 SWS
Self-Study	105 Hours
Recommended Prerequisites	none
Mandatory Prerequisites	▪ Lab requires attendance in the amount of: 10 Termine ▪ Participation in final examination only after successful participation in Lab
Recommended Literature	▪ R.W.G. Hunt, The Reproduction of Color ▪ M. Fairchild, Color Appearance Models, Wiley, 2nd ed. ▪ G. C. Holst, T. S. Lomheim, CMOS/CCD Sensors and Camera Systems, SPIE ▪ J. Nakamura, Image Sensors and Signal Processing for Digital Still Cameras, Taylor & Francis ▪ Reinhard/Ward/Pattanaik/Debevec, High Dynamic Range Imaging, Elsevier 2010 ▪ R. Gonzales/R. Woods/Eddins, Digital Image Processing Using Matlab, Prentice Hall, 2004 ▪ W. Pratt, Digital Image Processing, Wiley, 4th ed., 2007 ▪ A. Jain, Fundamentals of Digital Image Processing, Prentice Hall, 1988
Included in Elective Catalog	▪ WBA - Wahlbereich Allgemein ▪ WBK - Wahlbereich Kerngebiet ▪ WBT - Wahlbereich Technische Module
Included in Specialization	BIL - Bildtechnologie
Use of the Module in Other Study Programs	▪ DBT in Master Communication Systems and Networks PO3 ▪ DBT in Master Communication Systems and Networks PO4 ▪ DBT in Master Medientechnologie PO3
Specifics and Notes	
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6.6 DLO - Deep Learning und Objekterkennung

Module ID	DLO
Module Name	Deep Learning und Objekterkennung
Type of Module	Elective Modules
Recognized Course	DLO - image processing master
ECTS credits	5
Language	deutsch
Duration of Module	1 Semester
Recommended Semester	1-2
Frequency of Course	every summer term
Module Coordinator	Prof. Dr. Jan Salmen/Professor Fakultät IME
Lecturer(s)	Prof. Dr. Jan Salmen/Professor Fakultät IME

Learning Outcome(s)

> Die Teilnehmer*innen können selbständig entscheiden, in welchen Situationen sich der Einsatz von Verfahren aus dem Bereich Deep Learning anbietet. Sie können eine entsprechende Lösung entwerfen, iterativ verbessern und praktisch umsetzen. Mögliche Probleme auf dem Weg dahin (z.B. beim Erstellen eines Datensatzes oder beim Training) können sie qualifiziert analysieren und passende Ideen zur Bewältigung entwickeln. Da sie einen guten Überblick über die langjährigen Entwicklungen in Forschung und Technik haben, können sie qualifiziert auf aktuelle Herausforderungen und offene Fragen im Zusammenhang mit Deep Learning schauen. Die Studierenden werden so in die Lage versetzt, sich sowohl im weiteren Studienverlauf als auch im Berufsleben kompetent mit Ansätzen zu beschäftigen, die auf Deep Learning beruhen.

Module Contents

Lecture

> Deep learning algorithms and their application for object recognition in images.

Lab

> training of a neural network
>
> evaluation of the performance of a neural network

Teaching and Learning Methods	▪ Lecture ▪ Lab
Examination Types with Weights	▪ accompanying: exercise lab [ungraded] and ▪ final: (digital) written exam or oral examination or single/multiple choice [100%]
Workload	150 Hours
Contact Hours	34 Hours ≙ 3 SWS
Self-Study	116 Hours
Recommended Prerequisites	The students should have some basic knowledge about image processing and pattern recognition
Mandatory Prerequisites	Lab requires attendance in the amount of: 4 Termine
Recommended Literature	▪ I. Goodfellow, Y. Bengio und A. Courville. Deep Learning. MIT Press, 2016 ▪ C. C. Aggarwal. Neural Networks and Deep Learning: A Textbook. Springer, 2018 ▪ C. Bishop und H. Bishop. Deep Learning: Foundations and Concepts. Springer, 2024 ▪ D. V. Godoy. Deep Learning with PyTorch Step-by-Step: A Beginner’s Guide. Fundamentals. 2022 ▪ D. V. Godoy. Deep Learning with PyTorch Step-by-Step: A Beginner’s Guide. Computer Vision. 2022

Included in Elective Catalog	▪ WBA - Wahlbereich Allgemein ▪ WBK - Wahlbereich Kerngebiet ▪ WBT - Wahlbereich Technische Module
Included in Specialization	BIL - Bildtechnologie
Use of the Module in Other Study Programs	▪ DLO in Master Communication Systems and Networks PO3 ▪ DLO in Master Communication Systems and Networks PO4 ▪ DLO in Master Elektrotechnik PO3 ▪ DLO in Master Elektrotechnik und Informationstechnik PO1 ▪ DLO in Master Medientechnologie PO3 ▪ DLO in Master Technische Informatik PO3 ▪ DLO in Master Informatik und Systems-Engineering PO1
Specifics and Notes	
Last Update	19.7.2025, 14:32:16

6.7 ERMK - Entrepreneurship, Gewerblicher Rechtsschutz, Market Knowledge

Module ID	ERMK
Module Name	Entrepreneurship, Gewerblicher Rechtsschutz, Market Knowledge
Type of Module	Elective Modules
Recognized Course	GER - Industrial property protection
ECTS credits	5
Language	deutsch
Duration of Module	1 Semester
Recommended Semester	1-2
Frequency of Course	every term
Module Coordinator	Prof. Dr. Holger Weigand/Professor Fakultät IME
Lecturer(s)	Ladrière

Learning Outcome(s)

> Befähigung zum unternehmerischen Denken
>
> Einschätzung des Innovationspotentials neuer technischer Entwicklungen
>
> Verständnis der Mechanismen des Marktes im Hinblick auf neue technische Innovationen

Module Contents

Lecture

> Types of industrial property rights, significance for companies and inventors, significance of employee invention law and inventor personality law, prerequisites for protection, term of industrial property rights, structure of an application, life cycle from application to patent, subsequent applications, examination and opposition procedures, national, European and international applications, utility models, trademarks, design, law on the protection of secrets, professional field of patent engineer.
>
> Carry out a patent search; determine the relevant type of protective right for a given case; be able to correctly file an application with regard to its formal structure; weigh up the advantages and disadvantages of national, European and international applications in a specific application; check the validity of a patent; develop a basic IP strategy.

Seminar

> Types of industrial property rights, significance for companies and inventors, significance of employee invention law and inventor personality law, prerequisites for protection, term of industrial property rights, structure of an application, life cycle from application to patent, subsequent applications, examination and opposition procedures, national, European and international applications, utility models, trademarks, design, law on the protection of secrets, professional field of patent engineer.
>
> Carry out a patent search; determine the relevant type of protective right for a given case; be able to correctly file an application with regard to its formal structure; weigh up the advantages and disadvantages of national, European and international applications in a specific application; check the validity of a patent; develop a basic IP strategy.

Teaching and Learning Methods	▪ Lecture ▪ Seminar
Examination Types with Weights	▪ accompanying: oral contribution [100%]
Workload	150 Hours
Contact Hours	34 Hours ≙ 3 SWS
Self-Study	116 Hours
Recommended Prerequisites	

Mandatory Prerequisites	
Recommended Literature	
Included in Elective Catalog	WBA - Wahlbereich Allgemein
Included in Specialization	
Use of the Module in Other Study Programs	▪ ERMK in Master Elektrotechnik PO3 ▪ ERMK in Master Elektrotechnik und Informationstechnik PO1 ▪ ERMK in Master Technische Informatik PO3 ▪ XIM in Master Technische Informatik PO3 ▪ ERMK in Master Informatik und Systems-Engineering PO1
Specifics and Notes	
Last Update	19.7.2025, 14:32:16

6.8 ESD - Embedded Systems Design

Module ID	ESD
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
Included in Elective Catalog	▪ WBA - Wahlbereich Allgemein ▪ WBT - Wahlbereich Technische Module
Included in Specialization	
Use of the Module in Other Study Programs	▪ ESD in Master Communication Systems and Networks PO4 ▪ ESD in Master Elektrotechnik und Informationstechnik PO1 ▪ ESD in Master Technische Informatik PO3 ▪ ESD in Master Informatik und Systems-Engineering PO1
Permanent Links to Organization	ILU course
Specifics and Notes	
Last Update	19.7.2025, 14:32:16

6.9 ESY - Eingebettete Systeme in der Medientechnologie

Module ID	ESY
Module Name	Eingebettete Systeme in der Medientechnologie
Type of Module	Elective Modules
Recognized Course	ESY - Embedded Systems in Media Technology
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	Prof. Dr.-Ing. Dirk Poggemann/Professor Fakultät IME
Lecturer(s)	Prof. Dr.-Ing. Dirk Poggemann/Professor Fakultät IME

Learning Outcome(s)

> WAS: Studierende lernen aktuell verwendete Eingebettete Systeme in Kamerasystemen kennen, am Beispiel von FPGAs implementieren die Studierenden die Ansteuerung von Bildsensoren und Bilderarbeitungsalgorithmen für Kamerasysteme; Sie analysieren die Vor- und Nachteile unterschiedlicher Eingebetteter Systeme und aktuelle Trends in der Verwendung Eingebetteter Systeme in Kamerasystemen.
>
> WOMIT: Der Dozent vermittelt die Grundlagen zu Eingebetteten Systemen und verwendeten Hardwarebeschreibungssprachen, im Praktikum werden in praktischen Versuchen Ansteuerung und Verarbeitung in FPGAs implementiert. In der Vorlesung werden aktuelle wissenschaftliche Veröffentlichungen zur Verwendung Eingebetteter Systeme in der Medientechnologie, z.B. für die Bildverarbeitung, besprochen.
>
> WOZU: Ermöglicht das Erstellen technischer Systeme im Bereich Kameratechnik und die wissenschaftliche Auseinandersetzung mit Eingebetteten Systemen in der Medientechnologie.

Module Contents

Lecture

> - Microprocessors
> - FPGAs
> - Hardware Description Languages
> - Designprocess
> - Test and Debug
> - Control of CCD- and CMOS-Image-Sensors
> - Image Processing Algorithms

Lab

> exercises with FPGA-Board and CMOS-Image-Sensor

Project

Teaching and Learning Methods	▪ Lecture ▪ Lab ▪ Project
Examination Types with Weights	▪ accompanying: exercise lab [ungraded] and ▪ accompanying: project work [100%]
Workload	150 Hours

Contact Hours	45 Hours ≙ 4 SWS
Self-Study	105 Hours
Recommended Prerequisites	none
Mandatory Prerequisites	
Recommended Literature	▪ H.Flügel, FPGA-Design mit Verilog, Oldenbourg ▪ D.G.Bailey, Design for Embedded Image Processing on FPGAs, Wiley ▪ F.Kesel, Entwurf von digitalen Schaltungen und Systemen mit HDLs und FPGAs, Oldenbourg
Included in Elective Catalog	▪ WBA - Wahlbereich Allgemein ▪ WBK - Wahlbereich Kerngebiet ▪ WBT - Wahlbereich Technische Module
Included in Specialization	BIL - Bildtechnologie
Use of the Module in Other Study Programs	ESY in Master Medientechnologie PO3
Specifics and Notes	
Last Update	4.9.2025, 13:17:16

6.10 FTV - Forschungsprojekt virtuelle und erweiterte Realität

Module ID	FTV
Module Name	Forschungsprojekt virtuelle und erweiterte Realität
Type of Module	Elective Modules
Recognized Course	FTV - Research Project Virtual and Augmented Reality
ECTS credits	5
Language	englisch
Duration of Module	1 Semester
Recommended Semester	1-2
Frequency of Course	every term
Module Coordinator	Prof. Dr. Stefan Grünvogel/Professor Fakultät IME
Lecturer(s)	Prof. Dr. Stefan Grünvogel/Professor Fakultät IME

Learning Outcome(s)

WAS:
Selbstständig relevante wissenschaftliche Fragestellungen oder Hypothesen im Bereich VR / AR bewerten und entwickeln.

WOMIT:
Selbstständig wissenschaftliche Literatur im Bereich der virtuellen und erweiterten Realität durchdringen, zusammenfassen und präsentieren.
Fortgeschrittene Datenstrukturen und Algorithmen für VR/AR-Anwendungen erklären und vergleichen.

WOZU:
Um zukünftig wissenschaftlich zur arbeiten und wissenschaftlich Erkenntnisse anzuwenden und zu erweitern. (H2)

WAS:
Mit Hilfe verschiedener Methoden nach Antworten wissenschaftlicher Fragestellungen im Bereich VR / AR suchen.

WOMIT:
Es werden Werkzeuge und Methoden zur Entwicklung von VR/AR-Anwendungen verwendet und fortgeschrittene Technologien in VR und AR weiterentwickeln.
Dabei werden rechtliche und ethische Rahmenbedingungen und Nutzungsrechte berücksichtigt.

WOZU:
Es werden alle zukünftigen Handlungsfelder des Masterstudiengangs adressiert.

WAS:
Den eigenen Forschungsprozess selbst gestalten und reflektieren.

WOMIT:
Phasenübergreifende Qualitätssicherung und Anwendung wissenschaftlich fundierter und nachvollziehbarer Methoden sowie fachspezifischer Standards.

WOZU:
Dieses Learning-Outcome ist für das später wissenschaftliche Arbeiten notwendig.

WAS:
Forschungsergebnisse aufbereiten, kommunizieren und präsentieren.

WOMIT:
Das Zustandekommen der Forschungsergebnisse wird nachvollziehbar dokumentiert. In einer Abhandlung, die wissenschaftlichen Standards genügt, werden die Ergebnisse dargestellt und eine Fachpublikum präsentiert.

WOZU:
Um zukünftig wissenschaftliche Erkenntnisse zu erweitern und um in Führungs- bzw. Projektverantwortung in Fachteams kommunizieren zu können.

Module Contents

Project

> Explain and compare data structures and algorithms for VR/AR applications.
> Describe multimodal user interfaces.
> Describe input and output devices as well as specific hardware of virtual and augmented reality.
> Explain algorithmic and mathematical basics.

> Summarize and present scientific literature in the field of virtual and augmented reality.
> Explain and compare advanced data structures and algorithms for VR/AR applications.
> Use tools and methods for the development of VR/AR applications and further develop advanced technologies in VR and AR.
> Legal and ethical framework conditions and rights of use will be considered.
> Cross-phase quality assurance and application of scientifically sound and comprehensible methods as well as subject-specific standards.
> The results of the research will be documented in a comprehensible manner. The results will be presented to a specialist audience in a treatise that meets scientific standards.

Teaching and Learning Methods	Project
Examination Types with Weights	▪ accompanying: project work or term paper or oral contribution [100%]
Workload	150 Hours
Contact Hours	12 Hours ≙ 1 SWS
Self-Study	138 Hours
Recommended Prerequisites	▪ Modul VER: Kentnisse der Begriffe aus dem Bereich VR und AR sowie die Fertigkeit, selbstständig VR / AR - Anwendungen zu erstellen. ▪ Modul MCI: Grundlagen des Experiment Designs sowie der statistischen Auwertung. ▪ Knowledge of VR and AR terms and the competence to create VR / AR applications. Basics of experiment design and statistical evaluation.
Mandatory Prerequisites	Project requires attendance in the amount of: 3 Termine
Recommended Literature	▪ Relevante Foschungsliteratur. z.B IEEE VR, EuroVR, Siggraph, Sigchi usw.
Included in Elective Catalog	▪ WBA - Wahlbereich Allgemein ▪ WBK - Wahlbereich Kerngebiet ▪ WBT - Wahlbereich Technische Module
Included in Specialization	IMA - Interaktive Medienanwendungen
Use of the Module in Other Study Programs	FTV in Master Medientechnologie PO3
Specifics and Notes	
Last Update	19.7.2025, 14:32:16

6.11 IBD - InnoBioDiv

Module ID	IBD
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.
Included in Elective Catalog	▪ WBA - Wahlbereich Allgemein ▪ WBT - Wahlbereich Technische Module
Included in Specialization	
Use of the Module in Other Study Programs	▪ IBD in Master Communication Systems and Networks PO3 ▪ IBD in Master Communication Systems and Networks PO4 ▪ IBD in Master Elektrotechnik und Informationstechnik PO1 ▪ IBD in Master Technische Informatik PO3 ▪ IBD in Master Informatik und Systems-Engineering PO1
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

6.12 ITF - IT-Forensik

Module ID	ITF
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	
Included in Elective Catalog	▪ WBA - Wahlbereich Allgemein ▪ WBT - Wahlbereich Technische Module
Included in Specialization	
Use of the Module in Other Study Programs	▪ ITF in Master Communication Systems and Networks PO3 ▪ ITF in Master Communication Systems and Networks PO4 ▪ ITF in Master Elektrotechnik PO3 ▪ ITF in Master Elektrotechnik und Informationstechnik PO1 ▪ ITF in Master Medientechnologie PO3 ▪ ITF in Master Technische Informatik PO3 ▪ ITF in Master Informatik und Systems-Engineering PO1
Specifics and Notes	
Last Update	19.7.2025, 14:32:16

6.13 KOLL - Kolloquium zur Masterarbeit

Module ID	KOLL
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	
Included in Elective Catalog	
Included in Specialization	

Use of the Module in Other Study Programs	▪ KOLL in Master Communication Systems and Networks PO3 ▪ KOLL in Master Communication Systems and Networks PO4 ▪ KOLL in Master Elektrotechnik PO3 ▪ KOLL in Master Elektrotechnik und Informationstechnik PO1 ▪ KOLL in Master Medientechnologie PO3 ▪ KOLL in Master Technische Informatik PO3 ▪ KOLL in Master Informatik und Systems-Engineering PO1
Specifics and Notes	See also examination regulations §29.
Last Update	19.7.2025, 14:32:16

6.14 LCSS - Large and Cloud-based Software-Systems

Module ID	LCSS
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
Included in Elective Catalog	▪ WBA - Wahlbereich Allgemein ▪ WBT - Wahlbereich Technische Module
Included in Specialization	

Use of the Module in Other Study Programs	▪ LCSS in Master Communication Systems and Networks PO3 ▪ LCSS in Master Communication Systems and Networks PO4 ▪ LCSS in Master Elektrotechnik und Informationstechnik PO1 ▪ LCSS in Master Technische Informatik PO3 ▪ LCSS in Master Informatik und Systems-Engineering PO1
Permanent Links to Organization	Ilu course
Specifics and Notes	
Last Update	19.7.2025, 14:32:16

6.15 MAA - Masterarbeit

Module ID	MAA
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	
Included in Elective Catalog	
Included in Specialization	
Use of the Module in Other Study Programs	▪ MAA in Master Communication Systems and Networks PO3 ▪ MAA in Master Communication Systems and Networks PO4 ▪ MAA in Master Elektrotechnik PO3 ▪ MAA in Master Elektrotechnik und Informationstechnik PO1 ▪ MAA in Master Medientechnologie PO3 ▪ MAA in Master Technische Informatik PO3 ▪ MAA in Master Informatik und Systems-Engineering PO1
Specifics and Notes	See also examination regulations §24ff. Contact a professor of the faculty early on for the initial supervision of the thesis.
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6.16 MCI - Mensch-Computer-Interaktion

Module ID	MCI
Module Name	Mensch-Computer-Interaktion
Type of Module	Elective Modules
Recognized Course	MCI - Human Computer Interaction
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. Jonas Schild/Professor Fakultät IME
Lecturer(s)	Prof. Dr. Jonas Schild/Professor Fakultät IME

Learning Outcome(s)

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

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

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

Module Contents

Lecture

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

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

Lab

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

Seminar

Teaching and Learning Methods	▪ Lecture ▪ Lab ▪ Seminar
Examination Types with Weights	▪ accompanying: project work [100%]
Workload	150 Hours
Contact Hours	45 Hours ≙ 4 SWS
Self-Study	105 Hours
Recommended Prerequisites	none
Mandatory Prerequisites	▪ Lab requires attendance in the amount of: 2 Termine ▪ Seminar requires attendance in the amount of: Vorträge und Schlusspräsentation
Recommended Literature	▪ A. M. Heinecke: Mensch-Computer-Interaktion, Basiswissen für Entwickler und Gestalter, 2. Auflage, Springer, 2011 ▪ B. Shneiderman, C. Plaisant: Designing the User Interface: Strategies for Effective Human-Computer Interaction, Addison Wesley, 2009 ▪ S. Swink: Game Feel: A Game Designer's Guide to Virtual Sensation, Morgan Kaufmann Game Design Books, 2008 ▪ T. Sylvester: Designing Games: A Guide to Engineering Experiences, O'Reilly, 2013 ▪ J. Lazar, J.H. Feng, H. Hochheiser, Research Methods in Human-Computer-Interaction, Wiley, 2012
Included in Elective Catalog	▪ WBA - Wahlbereich Allgemein ▪ WBK - Wahlbereich Kerngebiet ▪ WBT - Wahlbereich Technische Module

Included in Specialization	IMA - Interaktive Medienanwendungen
Use of the Module in Other Study Programs	▪ MCI in Master Communication Systems and Networks PO3 ▪ MCI in Master Communication Systems and Networks PO4 ▪ MCI in Master Medientechnologie PO3 ▪ MCI in Master Technische Informatik PO3 ▪ MCI in Master Informatik und Systems-Engineering PO1
Specifics and Notes	
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6.17 MLWR - Maschinelles Lernen und wissenschaftliches Rechnen

Module ID	MLWR
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
Included in Elective Catalog	▪ WBA - Wahlbereich Allgemein ▪ WBT - Wahlbereich Technische Module
Included in Specialization	
Use of the Module in Other Study Programs	▪ MLWR in Master Elektrotechnik PO3 ▪ MLWR in Master Elektrotechnik und Informationstechnik PO1 ▪ MLWR in Master Technische Informatik PO3 ▪ MLWR in Master Informatik und Systems-Engineering PO1

Specifics and Notes	
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6.18 MP - Masterprojekt

Module ID	MP
Module Name	Masterprojekt
Type of Module	Mandatory Module
Recognized Course	MP - Master's project
ECTS credits	15
Language	deutsch und englisch
Duration of Module	1 Semester
Recommended Semester	2
Frequency of Course	every term
Module Coordinator	Studiengangsleiter(in) Master Medientechnologie
Lecturer(s)	verschiedene Dozenten*innen / diverse lecturers

Learning Outcome(s)

> Ablauf eines Projektes strukturieren
> Technische Informationen zu Projektgegenstand beschaffen
> Technische Aufgabe in sinnvolle Teilaufgaben zerlegen
> Spezifikation des Projektgegenstandes erstellen
> Software strukturiert erstellen (spezifizieren, erstellen, testen, dokumentieren)
> Gesamtsystem erstellen
> Benötigte technische Informationen identifizieren
> Technische Entscheidungen nach dem Stand der Technik und Wissenschaft treffen
> Komplexe Aufgaben arbeitsteilig bearbeiten
> Projektfortschritt kontrollieren, notwendige Korrekturmaßnahmen identifizieren und umsetzen
> Projektergebniss einem größeren Publikum präsentieren

Module Contents

Research Project

Teaching and Learning Methods	Research Project
Examination Types with Weights	▪ accompanying: project work [100%]
Workload	450 Hours
Contact Hours	12 Hours ≙ 1 SWS
Self-Study	438 Hours
Recommended Prerequisites	keine
Mandatory Prerequisites	Research Project requires attendance in the amount of: 3 Termine
Recommended Literature	
Included in Elective Catalog	
Included in Specialization	
Use of the Module in Other Study Programs	MP in Master Medientechnologie PO3

Specifics and Notes	
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6.19 PAP - Parallele Programmierung

Module ID	PAP
Module Name	Parallele Programmierung
Type of Module	Elective Modules
Recognized Course	PAP - Parallel Programming
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.-Ing. Arnulph Fuhrmann/Professor Fakultät IME
Lecturer(s)	Prof. Dr.-Ing. Arnulph Fuhrmann/Professor Fakultät IME

Learning Outcome(s)

> Medientechnische und interaktive Systeme beinhalten rechenintensive Berechnungen. Um Anforderungen an die Verarbeitung in Echtzeit erfüllen zu können, sind daher Kompetenzen und Wissen über die Grundlagen für die Analyse (HF1, HF2), den Entwurf (HF1, HF2), die Implementierung (HF1, HF2) und die Bewertung (HF1, HF2) paralleler Computerprogramme erforderlich.
>
> Folgende Kenntnisse und Kompetenzen werden im Detail vermittelt:
> - Grundlegende Konzepte, Modelle und Technologien der parallel Verarbeitung benennen, strukturieren, einordnen und abgrenzen
> - Aufgabenstellungen in Bezug auf die Programmierung paralleler Programme analysieren und strukturieren, einschlägige parallele Hardwarearchitektur zuordnen und auf Paralleldesign übertragen
> - Parallele Programme unter Einsatz geeigneter Tools analysieren und Ergebnisse nachvollziehbar darstellen
> - Leistungsfähigkeit paralleler Programme abschätzen und analysieren
> - Information aus englischen Originalquellen und Standards ableiten
>
> Kenntnisse und Basisfertigkeiten werden in der Vorlesung vermittelt. Begleitend dazu werden in den Übungen Kompetenzen und Fertigkeiten ausgebaut und inhaltliche Themen vertieft.

Module Contents

Lecture

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

Exercises / Lab

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

Teaching and Learning Methods	▪ Lecture ▪ Exercises / Lab
Examination Types with Weights	▪ accompanying: exercise lab [ungraded] and ▪ final: (digital) written exam or oral examination or term paper [100%]

Workload	150 Hours
Contact Hours	45 Hours ≙ 4 SWS
Self-Study	105 Hours
Recommended Prerequisites	The exercises require programming knowledge and the use of console-oriented programs in Linux-based operating systems.
Mandatory Prerequisites	Exercises / Lab requires attendance in the amount of: 2 Termine
Recommended Literature	▪ Wen-mei W. Hwu, David B. Kirk, Izzat El Hajj: Programming Massively Parallel Processors A Hands-on Approach - 4th Edition, 2022 ▪ Andrew S. Tanenbaum, Herbert Bos: Modern Operating Systems, 4th Edition, 2015 ▪ Jason Sanders: CUDA by Example: An Introduction to General-Purpose GPU Programming, Addison-Wesley Longman, 2010 ▪ R. Oechsle: Parallele und verteilte Anwendungen in Java, Hanser, 2011 ▪ P. Pacheco: An Introduction to Parallel Programming, Morgan Kaufmann, 2011
Included in Elective Catalog	▪ WBA - Wahlbereich Allgemein ▪ WBK - Wahlbereich Kerngebiet ▪ WBT - Wahlbereich Technische Module
Included in Specialization	IMA - Interaktive Medienanwendungen
Use of the Module in Other Study Programs	▪ PAP in Master Communication Systems and Networks PO3 ▪ PAP in Master Communication Systems and Networks PO4 ▪ PAP in Master Medientechnologie PO3 ▪ PAP in Master Technische Informatik PO3 ▪ PAP in Master Informatik und Systems-Engineering PO1
Specifics and Notes	
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6.20 RA - Reflexion Auslandssemester

Module ID	RA
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	
Included in Elective Catalog	
Included in Specialization	

Use of the Module in Other Study Programs	▪ RA in Bachelor Elektrotechnik und Informationstechnik PO1 ▪ RA in Bachelor Medientechnologie PO4 ▪ RA in Bachelor Informatik und Systems-Engineering PO1 ▪ RA in Master Communication Systems and Networks PO4 ▪ RA in Master Elektrotechnik und Informationstechnik PO1 ▪ RA in Master Informatik und Systems-Engineering PO1
Specifics and Notes	This course is aimed exclusively at students who have completed a semester abroad.
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6.21 RFSD - RF System Design

Module ID	RFSD
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
Included in Elective Catalog	▪ WBA - Wahlbereich Allgemein ▪ WBT - Wahlbereich Technische Module
Included in Specialization	
Use of the Module in Other Study Programs	▪ RFSD in Master Communication Systems and Networks PO3 ▪ RFSD in Master Communication Systems and Networks PO4 ▪ RFSD in Master Elektrotechnik und Informationstechnik PO1 ▪ RFSD in Master Technische Informatik PO3 ▪ RFSD in Master Informatik und Systems-Engineering PO1
Specifics and Notes	
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6.22 SEM - Masterhauptseminar Medientechnologie

Module ID	SEM
Module Name	Masterhauptseminar Medientechnologie
Type of Module	Mandatory Module
Recognized Course	SEM - Advanced Seminar on Media Technology
ECTS credits	10
Language	deutsch und englisch
Duration of Module	1 Semester
Recommended Semester	1
Frequency of Course	every winter term
Module Coordinator	Studiengangsleiter(in) Master Medientechnologie
Lecturer(s)	verschiedene Dozenten*innen / diverse lecturers

Learning Outcome(s)

- In ein anspruchvolles wissenschaftliches Thema aus dem Bereich der Medientechnologie einarbeiten
- Grundlegende Techniken der Arbeitsorganisation und -dokumentation beherrschen
- Angemessene Präsentationstechnik auswählen und beherrschen
- Fähigkeit zur freien Rede und anschaulicher Darstellung demonstrieren
- Fachliche Fragen sicher und angemessen formulieren (auch als Zuhörer)
- Auf Zuhörerfragen eingehen
- Angemessenes Feedback als Zuhörer geben
- Anspruchsvolle Themen kurz, prägnant und eingprägsam schriftlich darstellen
- Zielgruppengerechte Aufbereitung und Präsentation der eigenen Arbeitsergebnisse

Module Contents

Research Project

Teaching and Learning Methods	Research Project
Examination Types with Weights	▪ accompanying: term paper [100%]
Workload	300 Hours
Contact Hours	12 Hours ≙ 1 SWS
Self-Study	288 Hours
Recommended Prerequisites	none
Mandatory Prerequisites	Research Project requires attendance in the amount of: 2 Termine
Recommended Literature	
Included in Elective Catalog	
Included in Specialization	
Use of the Module in Other Study Programs	SEM in Master Medientechnologie PO3
Specifics and Notes	

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6.23 TSVP - Technologien und Systeme der Videoproduktion

Module ID	TSVP
Module Name	Technologien und Systeme der Videoproduktion
Type of Module	Elective Modules
Recognized Course	TSVP - Technologies and Systems of Video Production
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.-Ing. Ulrich Reiter/Professor Fakultät IME
Lecturer(s)	Prof. Dr.-Ing. Ulrich Reiter/Professor Fakultät IME

Learning Outcome(s)

> WAS: Studierende analysieren aktuelle und zukünftige Produktionstechnologien und Systeme audiovisueller Medien hinsichtlich unterschiedlicher Faktoren wie Anwendbarkeit, Potential, Kosten/Nutzen, etc. in verschiedenen exemplarischen Anwendungsszenarien. Sie lernen, Technologien aus teilweise anderen Anwendungsgebieten mit Hilfe wissenschaftlicher Methoden auf ihre Einsatzmöglichkeit in der Medienproduktion hin zu untersuchen. Die kritische Auseinandersetzung mit der technischen Literatur und die Anwendung der Regeln guten wissenschaftlichen Arbeitens befähigt sie, wissenschaftliche begründete Aussagen zu treffen.
>
> WOMIT: Dazu führen sie in kleinen Teams eine Literaturrecherche sowie evtl. Befragungen und Interviews mit Experten durch, mit Hilfe derer sie die betreffenden Technologien verstehen und eine Einordnung vornehmen können. Zum Abschluss des Projektes fertigen sie einen Bericht an und halten einen Fachvortrag.
>
> WOZU: Studierenden wird ein kritischer Umgang mit neuen Technologien ermöglicht, da sie wissenschaftlich arbeiten können. Sie können komplexe Technologien analysieren, daraus technologische Empfehlungen ableiten und somit fachliche Führungs- und Projektverantwortung übernehmen.

Module Contents

Project

> - mastering of methods of good scientific practice, especially with respect to information retrieval as well as to documentation and presentation of expert knowledge

> - expert knowledge in specific topics from the field of Technologies and Systems for Audiovisual Media Production, as well as from neighboring disciplines that are already or will become potentially relevant for the field of media production technologies

Teaching and Learning Methods	Project
Examination Types with Weights	▪ accompanying: project work or term paper or oral contribution [100%]
Workload	150 Hours
Contact Hours	12 Hours ≙ 1 SWS
Self-Study	138 Hours
Recommended Prerequisites	- basic knowledge in media production technologies and systems
Mandatory Prerequisites	▪ Project requires attendance in the amount of: 2 Termine ▪ Participation in final examination only after successful participation in Project
Recommended Literature	▪ diverse aktuelle Papers zum jeweiligen Thema

Included in Elective Catalog	▪ WBA - Wahlbereich Allgemein ▪ WBK - Wahlbereich Kerngebiet ▪ WBT - Wahlbereich Technische Module
Included in Specialization	TSA - Technologien und Systeme audiovisueller Medien
Use of the Module in Other Study Programs	▪ TSVP in Master Communication Systems and Networks PO3 ▪ TSVP in Master Communication Systems and Networks PO4 ▪ TSVP in Master Medientechnologie PO3
Specifics and Notes	
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6.24 VAE - Virtual Acoustic Environments

Module ID	VAE
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"
Included in Elective Catalog	▪ WBA - Wahlbereich Allgemein ▪ WBK - Wahlbereich Kerngebiet ▪ WBT - Wahlbereich Technische Module
Included in Specialization	TSA - Technologien und Systeme audiovisueller Medien
Use of the Module in Other Study Programs	▪ VAE in Master Communication Systems and Networks PO3 ▪ VAE in Master Communication Systems and Networks PO4 ▪ VAE in Master Elektrotechnik und Informationstechnik PO1 ▪ VAE in Master Medientechnologie PO3 ▪ VAE in Master Technische Informatik PO3 ▪ VAE in Master Informatik und Systems-Engineering PO1
Specifics and Notes	
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6.25 VAO - Forschungsprojekt virtuelle Akustik und objektbasiertes Audio

Module ID	VAO
Module Name	Forschungsprojekt virtuelle Akustik und objektbasiertes Audio
Type of Module	Elective Modules
Recognized Course	VAO - Research Project in Virtual Acoustics and Object Based Audio
ECTS credits	5
Language	deutsch, englisch bei Bedarf
Duration of Module	1 Semester
Recommended Semester	1-2
Frequency of Course	every term
Module Coordinator	Prof. Dr.-Ing. Ulrich Reiter/Professor Fakultät IME
Lecturer(s)	Prof. Dr.-Ing. Ulrich Reiter/Professor Fakultät IME

Learning Outcome(s)

> WAS: Studierende lernen Technologien aus den Themengebieten Virtuelle Akustik und Objektbasierte Audioproduktion zu analysieren, zu implementieren und anzuwenden. Sie lernen, fachspezifische Aufgabenstellungen mit Hilfe wissenschaftlicher Methoden und in einem begrenzten Zeitraum zu lösen. Die kritische Auseinandersetzung mit den gefundenen Lösungen und die Anwendung der Regeln guten wissenschaftlichen Arbeitens befähigt sie, wissenschaftliche Aussagen zu treffen.
>
> WOMIT: Dazu führen sie in kleinen Teams Projekte durch, in denen sie die kennengelernten Technologien exemplarisch implementieren und/oder anwenden. Zum Abschluss des Projektes fertigen sie eine Dokumentation an und halten einen Fachvortrag.
>
> WOZU: Studierenden wird ein kritischer Umgang mit neuen Technologien ermöglicht, da sie wissenschaftlich arbeiten können. Sie können komplexe Technologien entwickeln und fachliche Führungs- und Projektverantwortung übernehmen.

Module Contents

Project

> - development of a deep understanding for the properties of object based audio technologies
> - knowledge of simulation methods of virtual acoustics

> - confident handling of object based audio technologies and methods of virtual acoustics
> - mastering of methods of good scientific practice, especially with respect to information retrieval as well as to documentation and presentation of project results

Teaching and Learning Methods	Project
Examination Types with Weights	▪ accompanying: project work or term paper or oral examination [100%]
Workload	150 Hours
Contact Hours	12 Hours ≙ 1 SWS
Self-Study	138 Hours
Recommended Prerequisites	- knowledge of acoustics / room acoustics as well as audio engineering / digital audio technology - basic knowledge of audio signal processing and algorithms
Mandatory Prerequisites	Project requires attendance in the amount of: 80 % der Termine und Präsentation
Recommended Literature	▪ diverse aktuelle Papers zum Thema

Included in Elective Catalog	▪ WBA - Wahlbereich Allgemein ▪ WBK - Wahlbereich Kerngebiet ▪ WBT - Wahlbereich Technische Module
Included in Specialization	TSA - Technologien und Systeme audiovisueller Medien
Use of the Module in Other Study Programs	VAO in Master Medientechnologie PO3
Specifics and Notes	
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6.26 VER - Virtuelle und erweiterte Realität

Module ID	VER
Module Name	Virtuelle und erweiterte Realität
Type of Module	Elective Modules
Recognized Course	VER - Virtual and Augmented Reality
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	Prof. Dr.-Ing. Arnulph Fuhrmann/Professor Fakultät IME
Lecturer(s)	▪ Prof. Dr.-Ing. Arnulph Fuhrmann/Professor Fakultät IME ▪ Prof. Dr. Stefan Grünvogel/Professor Fakultät IME

Learning Outcome(s)

WAS:
Das Modul vermittelt folgende Kenntnisse und Fertigkeiten:
- Virtual- und Augmented-Reality-Anwendungen konzipieren, aufbauen und bewerten
- Interaktions und Navigationsverfahren erstellen
- Basistechnologien der virtuellen und erweiterten Reality weiterentwickeln
- Werkzeuge und Methoden zur Entwirklickung von VR/AR-Anwendungen verwenden
- Algorithmische und mathematische Grundlagen von VR/AR anwenden

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

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

Module Contents

Lecture

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

Lab

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

Seminar

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

Teaching and Learning Methods	▪ Lecture ▪ Lab ▪ Seminar
Examination Types with Weights	▪ accompanying: exercise lab [ungraded] and ▪ final: oral examination or term paper or project work [100%]
Workload	150 Hours
Contact Hours	45 Hours ≙ 4 SWS
Self-Study	105 Hours
Recommended Prerequisites	Computer Graphics Computer Animation
Mandatory Prerequisites	Lab requires attendance in the amount of: 2 Termine
Recommended Literature	▪ R. Dörner et al., Virtual und Augmented Reality (VR/AR): Grundlagen und Methoden der Virtuellen und Augmentierten Realität, Springer Vieweg, 2019 ▪ Schmalstieg und Höllerer, Augmented Reality – Principles and Practice, Addison Wesley, 2016 ▪ T. Akenine-Möller, et al., Real-Time Rendering Fourth Edition, Taylor & Francis Ltd., 2018 ▪ J. Jerald, The VR Book: Human-Centered Design for Virtual Reality, Acm Books, 2015
Included in Elective Catalog	▪ WBA - Wahlbereich Allgemein ▪ WBK - Wahlbereich Kerngebiet ▪ WBT - Wahlbereich Technische Module
Included in Specialization	IMA - Interaktive Medienanwendungen
Use of the Module in Other Study Programs	▪ VER in Master Communication Systems and Networks PO3 ▪ VER in Master Communication Systems and Networks PO4 ▪ VER in Master Medientechnologie PO3 ▪ VER in Master Technische Informatik PO3 ▪ VER in Master Informatik und Systems-Engineering PO1
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 WBA - Wahlbereich Allgemein

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 WBT - Wahlbereich Technische 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	
ATM	Ausgewählte Themen der Medientechnologie	5		
AVT	Audio- und Videotechnologien	5		TSA
AVV	Algorithmen der Videosignalverarbeitung	5	BIL	
DBT	Digitale Bildtechnik	5	BIL	
DLO	Deep Learning und Objekterkennung	5	BIL	

Module ID	Module Name	ECTS	included in Specialization		
ERMK	**Entrepreneurship, Gewerblicher Rechtsschutz, Market Knowledge**	5			
ESD	Embedded Systems Design	5			
ESY	Eingebettete Systeme in der Medientechnologie	5	BIL		
FTV	Forschungsprojekt virtuelle und erweiterte Realität	5		IMA	
IBD	InnoBioDiv	5			
ITF	IT-Forensik	5			
LCSS	Large and Cloud-based Software-Systems	5			
MCI	Mensch-Computer-Interaktion	5		IMA	
MLWR	Maschinelles Lernen und wissenschaftliches Rechnen	5			
PAP	Parallele Programmierung	5		IMA	
RFSD	RF System Design	5			
TSVP	Technologien und Systeme der Videoproduktion	5			TSA
VAE	Virtual Acoustic Environments	5			TSA
VAO	Forschungsprojekt virtuelle Akustik und objektbasiertes Audio	5			TSA
VER	Virtuelle und erweiterte Realität	5		IMA	

7.2 WBK - Wahlbereich Kerngebiet

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

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

- Specialization BIL - Bildtechnologie
- Specialization IMA - Interaktive Medienanwendungen
- Specialization TSA - Technologien und Systeme audiovisueller Medien

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		
AVT	Audio- und Videotechnologien	5			TSA
AVV	Algorithmen der Videosignalverarbeitung	5	BIL		
DBT	Digitale Bildtechnik	5	BIL		
DLO	Deep Learning und Objekterkennung	5	BIL		
ESY	Eingebettete Systeme in der Medientechnologie	5	BIL		
FTV	Forschungsprojekt virtuelle und erweiterte Realität	5		IMA	
MCI	Mensch-Computer-Interaktion	5		IMA	
PAP	Parallele Programmierung	5		IMA	
TSVP	Technologien und Systeme der Videoproduktion	5			TSA
VAE	Virtual Acoustic Environments	5			TSA
VAO	Forschungsprojekt virtuelle Akustik und objektbasiertes Audio	5			TSA
VER	Virtuelle und erweiterte Realität	5		IMA	

7.3 WBT - Wahlbereich Technische Module

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 WBK - Wahlbereich Kerngebiet

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			
ATM	**Ausgewählte Themen der Medientechnologie**	5				
AVT	Audio- und Videotechnologien	5				TSA
AVV	Algorithmen der Videosignalverarbeitung	5	BIL			
DBT	Digitale Bildtechnik	5	BIL			
DLO	Deep Learning und Objekterkennung	5	BIL			
ESD	**Embedded Systems Design**	5				
ESY	Eingebettete Systeme in der Medientechnologie	5	BIL			
FTV	Forschungsprojekt virtuelle und erweiterte Realität	5		IMA		
IBD	**InnoBioDiv**	5				
ITF	**IT-Forensik**	5				
LCSS	**Large and Cloud-based Software-Systems**	5				
MCI	Mensch-Computer-Interaktion	5		IMA		
MLWR	**Maschinelles Lernen und wissenschaftliches Rechnen**	5				
PAP	Parallele Programmierung	5		IMA		
RFSD	**RF System Design**	5				
TSVP	Technologien und Systeme der Videoproduktion	5				TSA
VAE	Virtual Acoustic Environments	5				TSA
VAO	Forschungsprojekt virtuelle Akustik und objektbasiertes Audio	5				TSA
VER	Virtuelle und erweiterte Realität	5		IMA		

8. Specializations

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

- A major field of study is considered successfully completed if the modules listed therein, comprising at least 15 ECTS, have been successfully completed.
- The completed areas of specialization are listed in a separate appendix to the degree certificate; if there is more than one, only parts of it may be listed upon request to the Examination Office.
- Upon request, a major field of study can be supplemented with additional suitable modules. Such a request must be submitted informally to the program director at least six months before planned participation in a module to be supplemented. The examination board decides on the acceptance of the request in consultation with the program director and appropriately qualified teaching staff.

8.1 BIL - Bildtechnologie

Anhand industrienaher Fallbeispiele werden in einem projektbezogenen Lehrkonzept Methoden und Techniken entwickelt, die intelligente Bild- und Videoanwendungen inkl. Hard- und Software von der Bildsensorik bis hin zu Objekterkennung und -verfolgung umsetzen. Insbesondere werden optische und elektronische Kameraeigenschaften modelliert, und diese Modelle zur Erzeugung von Trainingsdaten zu Deep Learning von neuronalen Faltungsnetzen genutzt. Zu den Highlights des Schwerpunkts Bildtechnik gehören: - Systemdesign kameratechnischer Systeme mit Controller- oder FPGA-basierter Steuerung der Bildsensorik und schneller Verarbeitung der Bildsignale - Verfahren zur Bildverbesserung (Farboptimierung, Image Enhancement) und Computational Photography (Mehrfachbildaufnahmetechniken wie HDR-Imaging oder Image Stacking) - Verfahren zur Bild- und Videokompression inkl. Bewegungsprediktion - Lokal adaptive Filterfunktionen (Rauschunterdrückung, Verschärfung) und Objekterkennung (Gesichter, Himmel, Vegetation …) mit neuronalen Faltungsnetzen (CNN)

Modules of the faculty:

Abbr.	Module Name	ECTS
AVV	Algorithmen der Videosignalverarbeitung	5
DBT	Digitale Bildtechnik	5
DLO	Deep Learning und Objekterkennung	5
ESY	Eingebettete Systeme in der Medientechnologie	5

8.2 IMA - Interaktive Medienanwendungen

In diesem Profil beschäftigen wir uns mit der Entwicklung von Algorithmen und Datenstrukturen zur Erzeugung von interaktiven Medienanwendungen, insbesondere im Bereich Virtual und Augmented Reality. Wir untersuchen aktuelle Themen zum Thema Mensch-Computer-Interaktion und führen eigenständige Forschungsprojekte durch.

Modules of the faculty:

Abbr.	Module Name	ECTS
FTV	Forschungsprojekt virtuelle und erweiterte Realität	5
MCI	Mensch-Computer-Interaktion	5
PAP	Parallele Programmierung	5
VER	Virtuelle und erweiterte Realität	5

8.3 TSA - Technologien und Systeme audiovisueller Medien

In diesem Profil werden aktuelle Technologien und Systeme audiovisueller Medien im Rahmen eines projektbezogenen Lehrkonzeptes exemplarisch untersucht, angewandt und weiterentwickelt. Im Fokus stehen dabei insbesondere: - Verfahren der Virtuellen Akustik, die interaktiv einen realitätsgetreuen räumlichen Klangeindruck vermitteln können, sowie zugehörige objektbasierte Audiokonzepte und Simulationsmethoden - komplexe Technologien und Systeme der Video-/Medien-Produktion, ihr Zusammenspiel sowie die daraus resultierenden Anforderungen und Workflows - Verfahren und Technologien zur Distribution von Mediendaten (Video- und Audiokompression, Übertragung, Multiplexing ...)

Modules of the faculty:

Abbr.	Module Name	ECTS
AVT	Audio- und Videotechnologien	5
TSVP	Technologien und Systeme der Videoproduktion	5
VAE	Virtual Acoustic Environments	5
VAO	Forschungsprojekt virtuelle Akustik und objektbasiertes Audio	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
AMA	Angewandte Mathematik	●	●	●	●	●	●	●		●	●	●		●				●				
ATM	Ausgewählte Themen der Medientechnologie	●			●		●	●		●	●	●	●	●	●	●		●				
AVT	Audio- und Videotechnologien	●	●	●	●	●	●	●	●	●	●	●		●	●		●	●				
AVV	Algorithmen der Videosignalverarbeitung	●	●	●	●	●	●	●	●									●				
DBT	Digitale Bildtechnik	●	●		●		●	●		●		●		●				●				
DLO	Deep Learning und Objekterkennung	●	●		●	●	●	●	●		●			●		●						
ERMK	Entrepreneurship, Gewerblicher Rechtsschutz, Market Knowledge																					
ESD	Embedded Systems Design	●				●	●		●	●	●	●		●				●		●	●	●
ESY	Eingebettete Systeme in der Medientechnologie	●			●	●	●		●	●	●	●		●				●				
FTV	Forschungsprojekt virtuelle und erweiterte Realität		●	●		●	●	●	●	●	●	●		●				●				
IBD	InnoBioDiv					●	●	●		●	●	●						●	●	●	●	●
ITF	IT-Forensik	●			●	●	●	●	●	●				●	●		●	●				
KOLL	Kolloquium zur Masterarbeit	●	●	●	●					●	●											
LCSS	Large and Cloud-based Software-Systems	●	●	●	●	●	●	●	●	●	●	●		●			●	●		●		●
MAA	Masterarbeit	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●

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
MCI	Mensch-Computer-Interaktion	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		●	
MLWR	Maschinelles Lernen und wissenschaftliches Rechnen							●		●			●	●		●	●	●			●	●
MP	Masterprojekt	●	●	●	●	●	●	●	●			●	●	●	●		●	●		●		●
PAP	Parallele Programmierung	●	●		●	●	●	●		●	●	●		●				●				
RA	Reflexion Auslandssemester																	●	●	●		
RFSD	RF System Design		●		●	●	●	●			●			●				●		●	●	
SEM	Masterhauptseminar Medientechnologie		●				●	●			●									●		
TSVP	Technologien und Systeme der Videoproduktion		●					●	●	●												
VAE	Virtual Acoustic Environments	●	●		●	●	●	●	●						●		●				●	●
VAO	Forschungsprojekt virtuelle Akustik und objektbasiertes Audio		●		●		●			●				●				●				
VER	Virtuelle und erweiterte Realität	●	●		●	●	●	●	●	●	●	●	●	●		●	●	●				

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
4.4	2025-09-18-14-14-00	1. Publizierte Prüfungsordnungs-Anhänge der reakkreditierten Studiengänge	Link
4.3	2025-09-08-09-32-00	1. Anwesenheiten in ESY reduziert 2. CSO mit Prüfungsform für begleitende Prüfung 3. Prüfungsordnungsversionen statt Jahreszahlen 4. Modulkürzel ohne Studiengang	Link
4.2	2025-08-22-14-20-00	1. Neues Modul "IT-Forensik" (ITF) in MaMT2024	Link
4.1	2025-06-24-18-55-09	1. Reakkreditierte Version	Link
4.0	2024-12-06-08-45-55	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